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QUADRANT III RFI FINAL REPORT

for
Portsmouth Gaseous Diffusion Plant
Piketon, Ohio

12/13/96

VOLUME 1

Text/Figures/Tables

Released
for
Public Review

2371

Department of Energy
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P.O. Box 700
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Phone: 614-897-5010

December 13, 1996
EF-21-8103

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Ms. Maria Galanti
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Southeast District Office
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Ms. Linda Welch, Chief
Division of Solid and Hazardous Waste
Ohio Environmental Protection Agency
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Columbus, Ohio 43266-0149

Dear Mesdames/Sir:

REVISED PAGE CHANGES FOR THE QUADRANT III RCRA FACILITY INVESTIGATION (RFI) FINAL REPORT

Enclosed are the revised page changes for the *Quadrant III RFI Final Report (Revision D3)* submitted for insertion into the aforementioned document. This submittal consists of two parts:

1. Volume I (in binder)
2. Revised pages for Volume 2 through 5 (in expandable folder)

A sheet of instructions detailing the procedure for removing and inserting pages of the *Quadrant III Final RFI Report* is included in the inside cover of Volume I. Also included inside the folder is a Roadmap for Responses to Ohio EPA (OEPA) and U. S. EPA comments, which is a guide to the exact locations in the text where each comment is addressed.

Please note that located throughout the report are other changes necessary to respond to both OEPA and U. S. EPA general comments. These changes will improve the usability and make the document consistent with other Quadrant RFI reports.

If you have any questions, please contact Kristi Wiehle of my staff at (614) 897-5020)

Sincerely,

for Eugene W. Gillespie
Site Manager
Portsmouth Site Office

EF-21:Wiehle

Enclosure

cc: T. David Taylor, LMES-PORTS
John Grabs, PRC Management
Administrative Records, MS-7614

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June 17, 1997
EF-21-8491

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Dear Mesdames/Sir:

RESPONSE TO USEPA TECHNICAL REVIEW COMMENTS ON QUADRANT III RFI FINAL REPORT DATED APRIL 3, 1997

On April 7, 1997, DOE received USEPA review comments regarding the above referenced report. Within this letter USEPA stated that they had "reviewed the above referenced RFI final reports, dated December 13, 1996, to determine if previously approved responses to the USEPA comments, dated January 11 and 23, 1995, and the USEPA review comments dated May 24, 1995, have been incorporated into the RFI final report." USEPA went on to state that; "Most of the approved responses have been incorporated. However, one specific comment still needs to be addressed." The specific comment referred to by the USEPA is specific comment 2 as numbered in the original USEPA comment's letter dated January 23, 1995.

Copies of revised Table 6.70 in response to specific comment 2 are enclosed for your review and final approval. Footnote 3 of this revised table has been added to summarize the reasons for not addressing potential recreational population exposure to contaminants in soils. Clarification of the land use utilized to evaluate exposure to the excavation worker was accomplished by changing the column heading on Table 6.70 from "Excavation Worker" to "Industrial Excavation Worker."

In a letter dated August 7, 1995, USEPA stated, "The Quadrant III Draft Final Report is approved provided that the appropriate changes are made to the text as indicated in DOE's response to comments." Submittal of this response resolves all outstanding USEPA comments regarding the Quadrant III RFI.

If you have any questions in regards to this matter please call Kristi Wiehle at (614) 897-5020.

Sincerely,

Eugene W. Gillespie
Site Manager
Portsmouth Site Office

EF-21:Wiehle

Enclosures

cc: Celeste Lipp, Ohio Dept. of Health
John Grabs, PRC Management
T. David Taylor, LMES-PORTS
Administrative Records, MS-7614

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October 22, 1997
EF-21-8805

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Ms. Linda Welch, Chief
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Dear Mesdames:

ADDITIONAL PAGE TO THE QUADRANT I, II, III AND IV RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) FACILITY INVESTIGATION (RFI) FINAL REPORTS

Enclosed is a copy of an additional page to the Quadrant I, II, III, and IV RFI Final Reports. As previously agreed, this page is to be inserted into its respective report to incorporate the Polycyclic Aromatic Hydrocarbon (PAH) position paper into the RFI Final Report. Please insert enclosed pages as the first page within the Executive Summary section of each report.

If you have any questions, please contact Kristi Wiehle of my staff at (614) 897-5020.

Sincerely,

John Sheppard
Eugene W. Gillespie
Site Manager
Portsmouth Site Office

EF-21:Wiehle

cc: Administrative Records, MS-7614
T. David Taylor, LMES-PORTS
Gene Jablonowski, USEPA

DOE/OR/11-1308/V1&D3
POEF-ER-4602/V1&D3

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QUADRANT III RFI FINAL REPORT

for
Portsmouth Gaseous Diffusion Plant
Piketon, Ohio

VOLUME 1

Text/Figures/Tables

December 13, 1996

By

Geraghty & Miller, Inc.
Environmental Services
Under LMES Contract 12B-00001V

Prepared For
U.S. Department of Energy
Office of Environmental Restoration and Waste Management
Under Budget and Reporting Code EW2010301

LOCKHEED MARTIN ENERGY SYSTEMS, INC.
Environmental Management and Enrichment Facility
P.O. Box 628 Piketon, Ohio 45661

Under Contract DE-AC05-76OR00001
to the
U.S. Department of Energy

First Draft Issued Unnumbered
Actual Date December 10, 1992

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LIST OF ABBREVIATIONS

ACGIH	American Council of Governmental and Industrial Hygienists
AET	Adverse Effects Threshold
ATSDR	Agency for Toxic Substances and Disease Registry
ARARs	Applicable or Relevant and Appropriate Requirements
AWQB	Ambient Water Quality Benchmarks
BARA	Barren Area
Bedford	Bedford Shale
BERA	Baseline Ecological Risk Assessment
Berea	Berea Sandstone
BFS	Bulk Fuel Storage
BOD	Biological Oxygen Demand
BRA	Baseline Risk Assessment
BRC	Big Run Creek
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
CDC	Centers for Disease Control
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
Ci/hr	Curies per hour
CLO_2	Hypochlorate
cm^2/sec	Square centimeters per second
cm^3/g	Cubic centimeters per gram
CMS	Corrective Measures Study
CO_2	Carbon Dioxide
COC	Chemicals of Concern
CPCB	Chemical and Petroleum Containment Basins
CPSC	Consumer Product Safety Commission

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LIST OF ABBREVIATIONS (continued)

CPVC	Chlorinated polyvinyl chloride
Cuyahoga	Cuyahoga Shale
DOCC	Description of Current Conditions
DQOs	Data quality objectives
ECAO	Environmental Criteria and Assessment Office
ED	Exposure duration
EDD	East Drainage Ditch
EDE	Effective dose equivalent
Eh	Oxidation Reduction Potential
Energy Systems	Lockheed Martin Energy Systems, Inc.
ER-L	Effects range low (10% of exposed aquatic organisms expected to show toxic effects)
ER-M	Effects Range-Median
ESD	Environmental Services Division
eV	Electron volts
ft^2	Square foot
ft^3	Cubic foot
ft/d	Feet per day
ft^2/d	Square feet per day
ft^3/d	Cubic feet per day
f_{oc}	Fraction of organic carbon
Gallia	Gallia Sand and Gravel
gal/month	Gallons per month
gal/yr	Gallons per year
g/cm^3	Grams per cubic centimeter
GC	Gas chromatograph
GCEP	Gaseous Centrifuge Enrichment Process
G.I.	Gastrointestinal

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LIST OF ABBREVIATIONS (continued)

gpd	Gallons per day
gpm	Gallons per minute
GSD	Geometric Standard Deviation
GTGS	Geotechnical Graphic System
GWQA	Groundwater Quality Assessment
HAZWRAP	Hazardous Waste Remedial Action Program
HEAST	Health Effects Assessment Summary Tables
HEPA	High Efficiency Particulate Air
HF	Hydrogen Fluoride
HI	Hazard index for noncarcinogenic effects
HQ	Hazard quotient
HSDB	Hazardous Substances Data Bank
IAEA	International Atomic Energy Agency
IARC	International Agency for Research on Cancer
IDLH	Immediate Danger to Life and Health
in/yr	Inches per year
IRIS	Integrated Risk Information System
IRM	Interim Remedial Measure
eV	Electron volts
kg	Kilogram
kg/yr	Kilograms per year
K_{ow}	Octanol-water partition coefficient
lbs	Pounds
LBC	Little Beaver Creek
LC_{50}	Lethal concentration in 50% of animals exposed
LOAEL	Lowest-observed-adverse-effect level
m^3/day	Cubic meters per day
mg/l	Milligrams per liter

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LIST OF ABBREVIATIONS (continued)

mg/kg	Milligrams per kilogram
$mg/m^2/day$	Milligrams of chemical per square meter body surface area per day
mg/m^3	Milligrams per cubic meter
mg U/kg	Milligrams of uranium per kilogram
mg U/liter	Milligrams of uranium per liter
mgd	Million gallons per day
Minford	Minford Clay and Silt
MOC	Method of Characteristics
MMOC	Modified Method of Characteristics
msl	Mean sea level
N	Normality
NA	Not analyzed
ND	Not detected
NDD	North Drainage Ditch
NEDD	Northeast Drainage Ditch
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Association
NOAEL	No-observed-adverse-effect level
NPDES	National Pollution Discharge Elimination System
NRC	National Research Council
NTP	National Toxicological Program
NCP	National Oil and Hazardous Substances Pollution Contingency
NCRPM	National Council on Radiation Protection and Measurements
NYSDEC	New York State Department of Environmental Conservation
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
OFR	Old Northwest Firing Range

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LIST OF ABBREVIATIONS (continued)

ORNL	Oak Ridge National Laboratory
OSTP	Office of Science and Technology Policy
OVEC	Ohio Valley Electric Corporation
PAHs	Polynuclear aromatic hydrocarbons
PCBs	Polychlorinated biphenyls
PCDFs	Polychlorinated dibenzofurans
PCE	Perchloroethylene
PCG	Preconditioned conjugate gradient
pCi/g	Picocuries per gram
pCi/l	Picocuries per liter
PERA	Preliminary Ecological Risk Assessment
PHYTOTOX	U.S. EPA plant toxicity database
PORTS	Portsmouth Gaseous Diffusion Plant
ppb	Parts per billion
ppm	Parts per million
PQLs	Practical quantitation limits
PRCL	Process Waste Lines
psi	Pounds per square inch
QAPjP	Quality Assurance Project Plan
QA/QC	Quality assurance/quality control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RCW	Recirculating Cooling Water
RfC	Reference concentration
RfD	Reference dose
RFI	RCRA Facility Investigation
RME	Reasonable maximum exposure
RSS	Residual sum of squares

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RSY	Railroad Spur Yard Storage Area
SASW	Sanitary Sewer System
SF	Slope factor for carcinogens
SIP	Strongly Implicit Procedure
SQL	Sample quantitation limit
SSOR	Slice-successive over-relaxation
STSW	Storm Sewer System
Sunbury	Sunbury Shale
SVOCs	Semivolatile organic compounds
SWMUs	Solid Waste Management Units
TAL	Target Analyte List
Tc	Technetium
TCL	Target Compound List
TE	Typical Exposure
TIC	Tentatively identified compound
TOC	Total organic carbon
UBK	Uptake/Biokinetic Model for lead
UCL	Upper control limit
μg/dl	Micrograms per deciliter
μg/hr	Micrograms per hour
μg/kg	Micrograms per kilogram
μg/l	Micrograms per liter
$\mu g/m^3$	Micrograms per cubic meter
μm	Micrometers
UBK	Uptake/Biokinetic
U.S. DOE	U.S. Department of Energy
U.S. EPA	U.S. Environmental Protection Agency
U.S. FDA	U.S. Food and Drug Administration

LIST OF ABBREVIATIONS (continued)

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USGS	U.S. Geological Survey
UST	Underground Storage Tank
VOCs	Volatile organic compounds
WDD	West Drainage Ditch
WHO	World Health Organization
yd^3	Cubic Yard

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PREFACE

Polycyclic Aromatic Hydrocarbons (PAHs) contamination at the Portsmouth Gaseous Diffusion Plant have been identified within this report on an individual Solid Waste Management Unit basis. However, determination of specific sources and levels of ecological and human health risk have not been addressed within this report. To obtain this information the reader is referred to the following U.S. Environmental Protection Agency (Region 5) and Ohio Environmental Protection Agency approved document:

U.S. Department of Energy (U.S. DOE). 1997. Risk Management Considerations for Polycyclic Aromatic Hydrocarbon Contamination at the Portsmouth Gaseous Diffusion Plant, Piketon Ohio, DOE/OR/11-140&D2, March 7, 1997.

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EXECUTIVE SUMMARY

The Portsmouth Gaseous Diffusion Plant (PORTS) (Ohio EPA Identification No. OH7890008983) is owned by the U.S. Department of Energy (U.S. DOE). The production facilities are leased and operated by the United States Enrichment Corporation. The facility was formerly operated by Martin Marietta Energy Systems until July 1, 1993. In 1995, through a corporate merger, Martin Marietta Energy Systems became Lockheed Martin Energy Systems, Inc (Energy Systems). Geraghty & Miller, Inc. was retained by Energy Systems in 1988 to conduct a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at the PORTS facility as part of the overall RCRA Corrective Action process that is currently ongoing at the site. RCRA Corrective Action is being conducted at the site under requirements and schedules specified in the Consent Decree issued by the Ohio Attorney General's office on August 29, 1989, and in the RCRA Section 3008(h) and CERCLA Section 106(c) Consent Order issued by the U.S. Environmental Protection Agency (U.S. EPA), Region V on September 29, 1989.

As stated in the Ohio Environmental Protection Agency (OEPA) Consent Decree and in the U.S. EPA Consent Order, the purpose of the RFI at PORTS is to acquire, analyze, and interpret data that will do the following:

1. Characterize the environmental setting, including groundwater, surface water and sediment, soil, and air.

2. Define and characterize sources of contamination.

3. Characterize the vertical and horizontal extent and degree of contamination of the environment.

4. Assess the risk to human health and the environment resulting from possible exposure to contaminants.

5. Support the Cleanup Alternatives Study/Corrective Measures Study (CAS/CMS), which will follow the RFI, if required.

The work plan for Phase I of the Quadrant III RFI was approved by the U.S. EPA and the OEPA on February 10, 1992. Phase I field work was conducted from April through August 1992. In an effort to streamline the RFI process, U.S. DOE and Energy Systems opted to implement Phase I field activities using new technologies that were not available when the original work plan was developed. During Phase I field activities, all soil (0 to 2 feet), sediment, and surface-water samples were collected and analyzed as specified in the approved Quadrant III RFI Work Plan (Geraghty & Miller, Inc., 1992a), the RFI Sampling Plan (Geraghty & Miller, Inc., 1992b), and the Laboratory Quality Assurance Project Plans (QAPjP) (Geraghty & Miller, Inc., 1992c; Energy Systems, 1991). However, all subsurface soil samples were collected using the Geoprobe sampling method, instead of the approved hollow-stem auger/split-spoon method.

In October 1992, the U.S. EPA formally disapproved of the revised approach to field activities. In response to this disapproval, a work plan for additional confirmatory work was submitted to both the U.S. EPA and the OEPA in November 1992. The primary objective of this work was to confirm the results of the Quadrant III Phase I RFI. Field work for the Confirmatory Investigation was conducted from October 1992 through December 1992. All confirmatory field activities were performed in accordance with the approved Quadrant III Confirmatory Work Plan (Geraghty & Miller, Inc., 1992d), the RFI Sampling Plan (Geraghty & Miller, Inc., 1992b), and the QAPjP (Geraghty & Miller, Inc., 1992c).

In December 1992, the Quadrant III Draft Final RFI Report was submitted to the U.S. EPA and the OEPA. This report included detailed discussions and interpretations of the results of the Phase I RFI (excluding the confirmatory sampling results) (Geraghty & Miller, Inc., 1992e). This report was unacceptable to both the U.S. EPA and the OEPA because all work specified in the approved work plan had not been performed.

In January 1993, the Quadrant III RFI Phase II Work Plan was formally submitted to both the U.S. EPA and the OEPA. This document was based primarily upon negotiations regarding the U.S. EPA and the OEPA requirements for the completion of the Quadrant III RFI. The Quadrant III RFI Phase II Work Plan was approved by both agencies on April 22, 1994. Field work for the Phase II investigation was performed from April 1994 through July 1994. All field activities conducted during this investigation were performed in strict accordance with the approved Quadrant III Phase II Work Plan (Geraghty & Miller, Inc., 1994), the RFI Sampling Plan (Geraghty & Miller, Inc. 1992b) and the QAPjP (Geraghty & Miller, Inc., 1992c).

All media except air were investigated during the RFI; the scope of air-related RFI activities has been negotiated with the OEPA and the U.S. EPA. The Final Air Pathway RCRA Facility Investigation Report was submitted to U.S. EPA and OEPA on November 1, 1996 (U.S. DOE, 1996b).

A total of 19 Solid Waste Management Units (SWMUs) were investigated during the Quadrant III Phase I and II RFIs at the PORTS facility. During the RFIs, soil samples, sediment samples, surface-water samples, and groundwater samples recommended in the approved work plans were collected as specified in the approved work plans and RFI Sampling Plan (Geraghty & Miller, Inc., 1992b). All samples were analyzed at Savannah Laboratories and at the PORTS Laboratory for parameters specified in the approved work plans using analytical methods and Level III data quality objectives (DQOs) described in the approved QAPjPs (Geraghty & Miller, Inc., 1992c; Energy Systems, 1991) for each laboratory.

During Phase I and Phase II RFI activities, soil and sediment samples were collected at each unit, where applicable, for comprehensive analyses of Target Compound List/Target Analyte List (TCL/TAL) constituents as listed in the U.S. Environmental Protection Agency Statement of Work for Organic (1988a) and Inorganic (1988b) Analyses. Surface-water and groundwater samples, where applicable, were analyzed for the Appendix IX list of constituents from RCRA 40 CFR Part 264. Solid and liquid samples were analyzed for fluoride, Freon-113, and radiological parameters (gross alpha, gross beta, total uranium, and technetium). Additional analyses for transuranic elements (neptunium and plutonium) and uranium isotopes (uranium-234, uranium-235, and uranium-238) were performed on a minimum of 5 percent of samples (during Phase I) and on selected Phase II samples, as specified in the approved Quadrant III Phase II RFI Work Plan (Geraghty & Miller, Inc., 1994). During Phase II, additional sampling and analyses were selected to support the risk assessment and the CAS/CMS and also to satisfy the U.S. EPA and the OEPA requirements.

Presented below is a discussion of how the objectives of the RFI (shown in bold-face below), as stated in the OEPA Consent Decree and U.S. EPA Consent Order, were achieved; recommendations for further action are also provided where applicable.

- ***Characterize the environmental setting, including groundwater, surface water and sediment, soil, and air***

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The environmental setting of Quadrant III and the PORTS facility are well understood as a result of this and previous investigations. In addition, background levels of naturally occurring constituents have been determined and are specified in the Background Sampling Investigation of Soil and Groundwater Final Report (BSI) (U.S. DOE, 1996a). Details of the Air RFI investigation are included in the Final Air Pathway RCRA Facility Investigation Report (U.S. DOE, 1996b).

- ***Define and characterize sources of contamination***

Potential sources of contamination were identified during development of the Quadrant III Description of Current Conditions (DOCC) (Geraghty & Miller, Inc., 1992f). Waste Characterization Data Sheets, which include detailed information regarding the physical and chemical properties of potential contaminants associated with these sources, were developed. The nature of the operations, the structure, and the history of waste disposal at each unit were also reviewed to develop SWMU-specific scopes of work. During this review, point sources of contamination were identified at three of the 19 SWMUs investigated. To complete the characterization of these three SWMUs, sediment and surface-water samples were collected for comprehensive analyses. These three SWMUs are as follows:

- X-230J5 West Environmental Sampling Building/Containment Basin
- X-2230N West Holding Pond No. 2
- Don Marquis Substation

Based upon the results of this sampling, the character of sediment, wastewater, surface water or soil associated with these SWMUs has been well defined. No additional investigation is required.

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- ***Characterize the vertical and horizontal extent and degree of contamination of the environment***

Contamination of environmental media was identified at 17 of the 19 SWMUs in Quadrant III. At 15 of these 17 SWMUs, the nature (constituents and maximum concentrations) and the vertical and horizontal extent of contamination were determined. Based upon the RFI data, further investigation is required at the X-740 Waste Oil Handling Facility. Closure work was conducted at the X-740 Waste Oil Handling Facility in October 1994 concurrent with the RFI and is referred to as the Phase II Investigation. Subsequent non-RFI field work at X-740 was conducted in the Spring of 1996; the results of this investigation are included in the Risk-Based RCRA Closure Plan for X-740. This document is currently being reviewed by OEPA. Additional non-RFI sampling was also conducted at the West Drainage Ditch during the Summer of 1996. A radiological survey of the soil and sediment in the West Drainage Ditch detected elevated technetium levels at 14 locations in West Drainage Ditch. Soil/sediment at these areas were excavated and subsequent confirmatory sampling indicated that the elevated radioactivity had been removed. This removal action and the sampling data will be addressed in the CAS/CMS.

- ***Assess the risk to human health and the environment resulting from possible exposure to contaminants***

An evaluation of potential risks to human health associated with each SWMU in Quadrant III was conducted as part of the RFI to support risk-based decisions regarding the need for further action. Risks were evaluated under two hypothetical future-use scenarios and the current-use scenario. An individual evaluation of soil and groundwater samples collected from areas adjacent to three SWMUs (Recirculating Cooling Water System [RCW], Sanitary Sewer System [SASW], and Storm Sewer

System [STSW]) was not performed because of the spatial variation of data associated with these units. However, data from these sampling locations were considered in the overall evaluation of the quadrant and in the evaluations of other SWMUs located near these SWMUs. It should be noted that the analysis of data collected during the RFI revealed no evidence of contamination that could be attributed directly to the RCW, the SASW, and the STSW lines.

Risk evaluation was performed using tentative background values for metals and naturally occurring radiological parameters that were calculated as part of the Quadrant I/Quadrant II Phase I RFIs. (Background concentrations of naturally occurring constituents must be established before risks can be fully evaluated.) Although background levels have since been revised and characterized in the BSI, background values for soil and groundwater were not approved until after the assessment of risk for Quadrant III SWMUs had been completed. Therefore, approved background values presented in the BSI are not incorporated into this report. In addition, inorganic constituents and naturally occurring radiological parameters were not evaluated in this report and will be assessed in the CAS/CMS. Risks associated with SWMUs in Quadrant III will be assessed after background values are evaluated in the CAS/CMS. If this reevaluation of risk indicates that risk levels associated with a unit are "acceptable," no further action will be proposed at that SWMU; if risk levels are "unacceptable," further action will be proposed. The results of the risk evaluation conducted during this investigation are summarized below.

Based on an analysis of risks associated with a hypothetical future-residential-use scenario and using a set of reasonable maximum exposure (RME) assumptions, SWMUs for which soil or groundwater data were collected can be separated into three groups classified according to potential carcinogenic and non-carcinogenic risk. Similarly, SWMUs for which surface water or sediment data were collected can be

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separated into risk categories based on a future-recreational-use scenario. Unless otherwise indicated, the following risk categorization is based on soil or groundwater data.

Target Risk Levels Not Exceeded

SWMUs in this group pose negligible carcinogenic risk (less than 10^{-6}) and negligible non-carcinogenic risk (hazard index [HI] less than 1) for the future-residential-use scenario. One SWMU is included in this group:

- West Drainage Ditch

Within Target Risk Levels

SWMUs in this group pose carcinogenic risks within the U.S. EPA range of concern (between 10^{-6} and 10^{-4}) for the future-residential-use scenario. Three SWMUs are included in this group:

- X-326 Process Building (X-326)
- X-744S, X-744T, X-744U Lithium Storage Warehouses (X-744S)
- X-2230N West Holding Pond No. 2 (X-2230N)

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Target Risk Levels Exceeded

SWMUs in this group pose a significant carcinogenic risk (greater than 10^{-4}) or significant non-carcinogenic risk (HI greater than 1) for the future-residential-use scenario. Twelve SWMUs are included in this group:

- X-230J3 West Environmental Sampling Building and Intermittent Containment Basin (X-230J3)
- X-230J5 West Holding Pond and Oil Separation Building (X-230J5)
- X-330 Process Building (X-330)
- X-530A Switchyard including X-530B Switch House; X-530C Test and Repair Building; X-530D Oil House; X-530E Valve House; X-530F Valve House; X-530G GCEP Oil Pumping Station (X-530A)
- X-615 Abandoned Sanitary Sewage Treatment Facility (X-615)
- X-616 Liquid Effluent Control Facility/Former Chromium Sludge Lagoons (X-616)
- X-740 Waste Oil Handling Facility (X-740)
- X-744N, X-744P, X-744Q Warehouse and Associated Oil Construction Headquarters Area (X-744N)
- X-745C West Cylinder Storage Yard (X-745C)
- X-6619 and X-6614E Sewage Treatment Facility (X-6619)
- X-7725 Recycle Assembly Building, X-7745R Recycle Assembly Storage Yard and Initial Construction Bulk Fuel Storage Area (BFS)
- Don Marquis Substation, Associated Containment Ponds and Drainage Ditches (DMRQ)

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Based on an evaluation of sediment and surface-water data under the future-recreation-use scenario, only one additional SWMU, the West Drainage Ditch, exceeded target risk levels.

The criteria used to determine if sufficient data have been collected during the RFI to support the risk assessment are discussed in Section 4.2 (Technical Approach) of this report. Based upon a review using these criteria, sufficient data for the risk assessment have been collected to support the risk assessment at all SWMUs investigated.

- ***Support the CAS/CMS***

The results of the RFI provide a foundation for the Quadrant III CAS/CMS. Data were collected during the Quadrant III Phase I and Phase II RFI to characterize the nature and extent of contamination in environmental media and the environmental setting of the facility (including site geology/hydrogeology and groundwater flow directions). Geotechnical data including bulk density, particle density, grain size analysis, soil permeability, Atterberg limits, standard Proctor analysis, soil porosity, cation exchange capacity, and total organic carbon were collected during the Quadrant I/Quadrant II Phase I/Phase II RFIs conducted in 1991 and 1993, respectively. This combination of geologic/hydrogeologic and geotechnical data will be critical in the evaluation of corrective measure technologies that will be performed as part of the CAS/CMS. A preliminary evaluation of applicable or relevant and appropriate requirements (ARARs) for the PORTS facility was conducted in 1992 (Houlberg et al., 1992). A complete review of ARARs will be conducted during the CAS/CMS.

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1.0 INTRODUCTION

1.1 Background

The Portsmouth Gaseous Diffusion Plant (PORTS) (Ohio EPA Identification No.: OH7890008983) is owned by the U.S. Department of Energy (U.S. DOE). The production facilities are leased and operated by the United States Enrichment Corporation. The facility was formerly operated by Martin Marietta Energy Systems until July 1, 1993. In 1995, through a corporate merger, Martin Marietta Energy Systems, Inc., became Lockheed Martin Energy Systems, Inc. (Energy Systems). Geraghty & Miller, Inc. was retained by Energy Systems in 1988 to conduct a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) at the PORTS facility as part of the overall RCRA Corrective Action process that is currently ongoing at the site. RCRA Corrective Action is being conducted at the site under requirements and schedules specified in the Consent Decree issued by the Ohio Attorney General's office on August 29, 1989, and in the RCRA Section 3008(h) and CERCLA Section 106(c) Consent Order issued by the U.S. Environmental Protection Agency (U.S. EPA), Region V on September 29, 1989.

The PORTS facility is located near Piketon, Ohio, in the south-central part of the state. The active plant site (the PORTS facility) encompasses approximately 1,000 acres of the 3,714-acre U.S. DOE reservation (reservation). The principal process at the PORTS facility is the separation of uranium isotopes via gaseous diffusion. The PORTS facility has been operating since 1954, enriching uranium for use in commercial nuclear reactors and previously for the nuclear navy. Support operations include the feed and withdrawal of material from the primary process, water treatment for sanitary and cooling purposes, decontamination of equipment removed from the plant for maintenance or replacement, recovery of uranium from various waste materials, and treatment of sewage wastes and cooling-water blowdown. The construction and operation and maintenance of this facility require the use of a wide range of commercially available chemicals. Continuous operation of the plant since 1954 has resulted in the generation of inorganic, organic, and low-level radioactive waste materials.

As discussed in detail in the Quadrant III Description of Current Conditions (DOCC) (Geraghty & Miller, Inc., 1992a), the PORTS facility has been separated into quadrants. Each quadrant (see Section 2.0, Characterization of Environmental Setting) roughly corresponds to a distinct groundwater flow cell within the primary water-bearing unit beneath the site and has been investigated separately.

The work plan for Phase I of the Quadrant III RFI (Geraghty & Miller, Inc., 1992b) was approved by the U.S. EPA and the Ohio Environmental Protection Agency (OEPA) on February 10, 1992. Phase I field work was conducted from April through August 1992. In an effort to streamline the RFI process, U.S. DOE and Energy Systems opted to implement Phase I field activities using new technologies that were not available when the original work plan was developed. During Phase I field activities, all soil (0 to 2 feet), sediment, and surface water samples were collected and analyzed as specified in the approved Quadrant III Phase I Work Plan (Geraghty & Miller, Inc., 1992b) and RFI Sampling Plan (Geraghty & Miller, Inc., 1992c). However, all subsurface soil samples were collected using the Geoprobe sampling method instead of the approved hollow-stem auger/split-spoon method. All of these samples were analyzed in accordance with the approved Quadrant III Phase I Work Plan (Geraghty & Miller, Inc., 1992b), the RFI Sampling Plan (Geraghty & Miller, Inc., 1992c), and the Quality Assurance Project Plan (QAPjP) (Geraghty & Miller, Inc., 1992d). In addition, a total of 14 PVC monitoring wells were installed in Quadrant III instead of the 38 stainless steel wells specified in the approved work plan. These 14 locations

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were selected from among the 38 approved locations because they provided additional data that could supplement data from existing wells. All of these wells were sampled and analyzed in accordance with the approved RFI Sampling Plan (Geraghty & Miller, Inc., 1992c) and QAPjPs (Geraghty & Miller, Inc., 1992d; Energy Systems, 1991).

In October 1992, the U.S. EPA formally disapproved of the revised approach to field activities. In response to this disapproval, a work plan for additional confirmatory work was submitted to both the U.S. EPA and the OEPA in November 1992 (Geraghty & Miller, Inc., 1992e). The primary objective of this work was to confirm the results of the Quadrant III Phase I RFI. Field work for the Confirmatory Investigation was conducted from October 1992 through December 1992. All confirmatory field activities were performed in accordance with the approved Quadrant III Confirmatory Sampling Plan (Geraghty & Miller, Inc., 1992e), the approved RFI Sampling Plan (Geraghty & Miller, Inc., 1992c) and QAPjP (Geraghty & Miller, Inc., 1992d). The scope of this work included the installation and sampling of seven stainless steel monitoring wells, the drilling of twenty soil borings, and the collection of six hand-augered soil samples, and one surface water sample.

In December 1992, the Quadrant III Draft Final RFI Report (Geraghty & Miller, Inc., 1992f) was submitted to the U.S. EPA and the OEPA. This report included detailed discussions and interpretations of the results of the Phase I RFI. This report was unacceptable to both the U.S. EPA and the OEPA because all work specified in the approved work plan had not been performed.

In January 1993, the Quadrant III RFI Phase II Work Plan (Geraghty & Miller, Inc., 1994) was formally submitted to both the U.S. EPA and the OEPA. This document was based primarily upon negotiations regarding the U.S. EPA and the OEPA requirements for the completion of the Quadrant III RFI, which were

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conducted from October 1992 through January 1993. The Quadrant III RFI Phase II Work Plan (Geraghty & Miller, Inc., 1994) was approved by both agencies on April 22, 1994. Field work for the Phase II investigation was performed from April 1994 through July 1994. All field activities conducted during this investigation were performed in strict accordance with the Quadrant III Phase II Work Plan (Geraghty & Miller, Inc., 1994), approved RFI Sampling Plan (Geraghty & Miller, Inc., 1992c) and QAPjP (Geraghty & Miller, Inc., 1992d).

All media except air were investigated during the RFI; the scope of air-related RFI activities has been negotiated with the OEPA and the U.S. EPA. The Final Air Pathway RCRA Facility Investigation Report was submitted to U.S. EPA and OEPA on November 1, 1996 (U.S. DOE, 1996).

1.2 Purpose of This Investigation

As stated in the OEPA Consent Decree and in the U.S. EPA Consent Order, the purpose of the RFI at PORTS is to acquire, analyze, and interpret data that will allow the following:

1. Characterize the environmental setting, including surface water and sediment, groundwater, soil, and air.

2. Define and characterize sources of contamination.

3. Characterize the vertical and horizontal extent and degree of contamination of the environment.

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4. Assess the risk to human health and the environment resulting from possible exposure to contaminants.

5. Support the Corrective Measures Study (CMS), which will follow the RFI, if required.

1.3 Conceptual Approach to RCRA Corrective Action

The conceptual approach to the RCRA Corrective Action process in the Quadrant III RFI Phase II is summarized on Figure 1.1. The first step in the process was to identify solid waste management units (SWMUs) with the potential for a release or specified in the U.S. EPA Consent Order or OEPA Consent Decree as requiring further action. The primary focus of the RFI was to determine if releases to the environment have occurred from SWMUs and to collect data to support an evaluation of risk for each SWMU and for the quadrant. If a release to the environment was found, an attempt was made to determine the nature and extent of the contamination sufficiently to support an evaluation of risk. In cases where the nature and extent of contamination were not sufficiently determined, additional investigation is recommended.

An evaluation of risks associated with each SWMU was performed using tentative background values calculated during the Quadrant III RFI. (Background concentrations of naturally occurring constituents must be established before risks can be fully evaluated). Risks associated with SWMUs in Quadrant III will be reevaluated after background values are established. If this reevaluation of risk indicates that risk levels associated with a unit are "acceptable," no further action will be proposed at that SWMU; if risk levels are "unacceptable," further action will be proposed.

This report presents a description of site conditions and identifies potential contaminants and primary pathways for releases at each SWMU. The investigation performed at each SWMU is summarized and the results of each investigation are presented. The results for each SWMU are discussed in detail to determine if the objectives of the RFI have been achieved. Conclusions regarding the RFI and recommendations for further action at selected SWMUs are also included.

1.4 References

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2.0 CHARACTERIZATION OF ENVIRONMENTAL SETTING

The characterization of the environmental setting is discussed below in terms of physiographic setting, site geology, and hydrogeology. Detailed discussions regarding groundwater flow in each of the quadrants of the PORTS facility are also provided.

2.1 Physiographic Setting of the PORTS Facility

The PORTS facility is located within the Appalachian Plateau physiographic province approximately 20 miles south of the limit of glaciation in Ohio (Feneman, 1938). As a result, the geologic setting of the site has been heavily influenced by drainage associated with glacial events. The PORTS facility occupies an upland area of Southern Ohio with an average land surface elevation of 670 feet above mean sea level (msl) (Plates I and II in Appendix A). The terrain surrounding the plant site consists of marginal farmland and wooded hills, generally with less than 100 feet of relief. As shown on Figure 2.1, the plant is located within a mile-wide abandoned river valley situated 130 feet above the level of the Scioto River, which lies approximately 1 mile to the west.

2.2 Geology of the PORTS Facility

The geology of the PORTS facility has been characterized through the drilling of over 1,200 borings throughout the site. The near-surface geologic materials that influence the hydrologic system at the PORTS facility consists of several bedrock formations and unconsolidated deposits. The bedrock formations include the Bedford Shale, the Berea Sandstone, the Sunbury Shale, and the Cuyahoga Shale. The unconsolidated deposits of clay, silt, sand, and gravel comprise the Minford clay and silt and the Gallia sand and gravel of the Teays formation. Both classes of geologic material and the recent geologic history are discussed below in detail.

Prior to the Pleistocene glaciation, the Teays River and its tributaries were the dominant drainage systems in Ohio. The Teays River originated in the Piedmont region of Virginia and North Carolina and entered Ohio from the south in Scioto County. The Teays River flowed southeast to northwest passing approximately 3 miles north of the location now occupied by the PORTS facility (Figure 2.1). In the vicinity of the PORTS facility, the location of the ancient Teays River Valley, currently occupied by Big Beaver Creek, is easily visible on topographic maps. The Portsmouth River, a tributary of the Teays, flowed north across the plant site location between bluffs of Cuyahoga Shale. The Portsmouth River cut down through the Cuyahoga Shale and into the Sunbury Shale and Berea Sandstone, depositing fluvial silt, sand, and gravel of the Gallia member of the Teays Formation (Figures 2.1 and 2.2).

Approximately one million years ago, a glacier advancing from the north blocked the northwestward flow of the Teays River. This resulted in the creation of Lake Tight, which occupied the valleys of the Teays River and its tributaries, including the Portsmouth River. Lacustrine silt and clay (Minford), indicative of low-energy conditions, were deposited on the lake bottom over the meandering Gallia stream deposits. The basal 10 to 15 feet of the Minford commonly consists of relatively clean silt (Figure 2.3), reflecting shallow lake levels and reworked sediment or possibly Portsmouth River over-bank deposits. Above this silt layer lies a series of laminated clays that are interpreted to represent sediments deposited as glacial Lake Tight grew deeper and more extensive.

Eventually, Lake Tight overflowed its banks and initiated the high-volume and high-energy lower-elevation drainage paths during the time known as Deep Stage drainage. The most significant Deep Stage stream in southern Ohio was the south-flowing Newark River (Figure 2.4). The Newark River occupied the former Teays River Valley from Chillicothe to Waverly, bypassed the area of the PORTS facility, then occupied the former Portsmouth River Valley south to Portsmouth. As the glaciers retreated, meltwater flowed down the Newark River Valley, partially backfilling it with outwash. The present-day Scioto River flows in this valley on top of a thick layer of outwash.

2.2.1 Bedrock Geology

Mississippian-age clastic sedimentary rocks underlie 30 to 45 feet of unconsolidated sediments beneath the PORTS facility (Plates III, IV and V in Appendix A). The bedrock formations encountered during environmental investigations at the site are, from oldest to youngest, the Bedford Shale, the Berea Sandstone, the Sunbury Shale, and the Cuyahoga Shale. A lithologic fence diagram from Quadrant III is presented on Plate IV (Appendix A). A detailed discussion of each of these bedrock formations is presented below.

The Bedford Shale is the lowest stratigraphic unit encountered during environmental investigative activities at the site. The typical depth to the top of this formation at the PORTS facility is 70 to 100 feet below ground surface. The Bedford Shale averages 100 feet in thickness and is composed of thinly bedded shale with interbeds and laminations of gray, fine-grained sandstone and siltstone. Sandstone interbeds are predominate at the top of the Bedford, but decrease in frequency with depth. The Bedford Shale acts as a lower confining unit for the overlying Berea Sandstone.

The Berea Sandstone is a light gray, thickly bedded, fine-grained sandstone with thin shale laminations. The Berea averages 35 feet in thickness; however, the lower 10 feet has numerous shale laminations and is very similar to the underlying Bedford Shale. This gradational contact does not allow for a precise determination of the thickness of the Berea. Regionally, the Berea Sandstone is used for production of oil and gas; however, near the PORTS facility, the Berea is the uppermost water-bearing bedrock unit. Generally, within the perimeter road, the Berea is the uppermost bedrock unit beneath the western part of the PORTS facility, but is overlain by the Sunbury Shale to the east.

The Sunbury Shale is a black, very carbonaceous shale. In outcrops, the Sunbury is fissile and highly fractured, but in cores obtained during bedrock drilling at the PORTS facility, the Sunbury has been found to be coherent. A thin (1- to 3-inch) zone of sulfide mineralization occurs locally at the contact between the Sunbury and the underlying Berea. The Sunbury is 20 feet thick beneath much of the PORTS facility, but thins westward due to erosion by the ancient Portsmouth River and is absent on the western half of the site (Plate V in Appendix A). It is also absent in the drainage of Little Beaver Creek downstream of X-611A Lime Sludge Lagoons where it has been removed by recent erosion. The Sunbury Shale underlies the unconsolidated Gallia beneath the eastern portion of the plant (Figure 2.2) and the Cuyahoga Shale outside of the Portsmouth River Valley.

The Cuyahoga Shale, the youngest and uppermost bedrock unit at the site, forms the hills surrounding the plant. The Cuyahoga has been eroded from the active part of the PORTS facility (Figure 2.2). The Cuyahoga consists of gray, thinly bedded shale with scattered lenses of fine-grained sandstone and reaches a local thickness of approximately 160 feet.

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2.2.2 Unconsolidated Sediments

Unconsolidated sediments in the vicinity of the PORTS facility fill the ancient Portsmouth River Valley to depths of approximately 30 to 40 feet. The unconsolidated sediments are divided into two members of the Teays Formation, the Minford clay and silt and the Gallia sand and gravel. Both of these members are discussed below in detail beginning with the older Gallia.

2.2.2.1 Gallia Sand and Gravel

Prior to Pleistocene glaciation, the Portsmouth River meandered north through the valley currently occupied by the PORTS facility, depositing the sand and gravel of the Gallia. A contour map of Gallia thickness, developed from more than 1,100 data points, is presented on Plate VI (Appendix A). The areas of thickest accumulation of Gallia shown on this plate may represent the channel location just prior to the formation of Lake Tight. The ancient channel extends from the south near Big Run Creek, northward along the eastern side of the valley, then curves to the west under the southern end of the X-330 building, and continues north along the western side of the valley (Plates III and VI in Appendix A). A meander valley of the Portsmouth River was cut through the Cuyahoga Shale east of the site, as shown on Figure 2.1. Thick Gallia deposits are present where this secondary meander valley intersects the main valley near X-701B.

The Gallia averages 3 to 4 feet in thickness at the site and is characterized by poorly sorted sand and gravel with silt and clay. (Law Engineering Testing Company [1978] indicated that the Gallia has an average clay content of 30 percent.) Channel migration and variation in depositional environments that occurred during deposition of the Gallia resulted in the variable thickness of the Gallia (Plate VI in Appendix A).

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Valley walls of the ancient Portsmouth River formed a natural barrier for deposition of Gallia channel deposits. Gallia deposits are generally absent above an approximate elevation of 655 feet above msl.

Due to similar depositional environments and source material, deposits from modern streams at the site are often visually indistinguishable from Gallia deposits. This similarity may have resulted in an overestimation of Gallia thickness, such as near the X-734 landfill and near the Old Firing Range. The modern surface-water drainage has also eroded the unconsolidated sediments, resulting in locally thin or absent Gallia and Minford.

2.2.2.2 Minford Clay and Silt

The Minford is the uppermost stratigraphic unit beneath the PORTS facility. The Minford averages 20 to 30 feet in thickness at the PORTS facility (Plate VII in Appendix A), and grades from predominantly silt and very fine sand at its base to clay near the surface. The upper clay unit averages 16 feet in thickness, is reddish-brown, plastic, and silty, and contains traces of sand and fine gravel in some locations. At Quadrant III, the Minford reaches thicknesses of 30 feet. These thicknesses may be exaggerated due to construction-filling operations as discussed below. The lower silt unit averages 7 feet in thickness, is yellow-brown, and semi-plastic, and contains varying amounts of clay and very fine sand. The contact between silt and clay is gradational. A study by Law Engineering Testing Company (1978) estimated that silt content in the Minford as a whole is approximately 33 percent.

Variability in bedrock topography during Minford deposition and downcutting by modern streams also affect Minford thickness. The Minford is thinnest where it overlies bedrock highs. Around the perimeter of the PORTS facility, the Minford thins and pinches out laterally against the bedrock valley walls that enclosed Lake Tight. Minford deposits are generally absent above an elevation of 685 feet msl along the valley walls.

Soil, colluvium, and recent alluvium are present in varying amounts at the surface near the PORTS facility. During the initial grading of the site, the deposits within the perimeter road were reworked to a depth as great as 20 feet by pre-construction cut and fill activity and locally replaced with disturbed Minford clay and silt or fill material (Figure 2.5). Figure 2.5 was constructed by comparing pre-site topography with recent topography. In most cases, the fill is indistinguishable from the undisturbed Minford. In summary, the combination of construction activities, bedrock topography, and erosion by modern streams has influenced the areal extent and thickness of the Minford at the PORTS facility.

2.2.3 Geologic Structure

The geologic structure of the area is very simple, with the Mississippian strata (Cuyahoga, Sunbury, Berea, and Bedford) dipping gently to the east-southeast at approximately 30 feet per mile (0.3 degree). There are no known geologic faults in the area. Outcrops of the Sunbury, Berea, and Bedford Formations show two distinct joint sets (N65°E and N25°W). Bedding-plane fractures are also present in the bedrock formations.

The occurrence of bedrock outcrops at the PORTS facility is governed by the regional dip of the bedrock units, erosion caused by the modern surface-water drainage systems, and bedrock topography. The regional eastern dip and subsequent erosion of bedrock units resulted in thinning of the Sunbury formation from approximately 20 feet at the eastern boundary of the site to zero at the center of the site (Plate V in

Appendix A). Therefore, unconsolidated sediments overlie the Berea Sandstone in the western part of the site and the Sunbury Shale in the eastern part. These differences in bedrock lithology are largely responsible for the hydrogeologic differences between the eastern and western parts of the PORTS facility.

Bedrock highs that existed prior to and during deposition of the unconsolidated sediments are also responsible for bedrock outcrop patterns at the PORTS facility. Bedrock outcrops, consisting of the Sunbury Shale and the overlying Cuyahoga Shale, are present along the valley walls that enclosed the Portsmouth River and Lake Tight. These bedrock highs are the result of differential erosion and entrenchment of the Portsmouth River.

Erosion by the modern surface-water drainage system into the Sunbury and Berea is also responsible for bedrock outcrops at the PORTS facility (Figure 2.6). Unconsolidated Minford and Gallia deposits have been eroded by modern streams, resulting in exposure of the Sunbury Shale, Berea Sandstone, and Bedford Shale in low areas. These outcrops are generally limited to narrow exposures within the valleys of the drainage systems. In summary, a combination of regional bedrock dip, localized bedrock topography, and modern stream erosion are responsible for the bedrock outcrop patterns observed at the PORTS facility.

2.3 Hydrogeology of the PORTS Facility

The groundwater flow system at the PORTS facility includes two aquifers (the bedrock Berea Sandstone and the unconsolidated Gallia) and two aquitards (the Sunbury Shale and the unconsolidated Minford) (see Figure 2.3). The basal silt portion of the Minford is generally grouped with the Gallia to form the uppermost and primary aquifer at the facility. As discussed below, the hydraulic properties of these units have

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been well defined during previous investigations at the facility. Groundwater flow at the site has also been well defined as a result of this and previous investigations. Groundwater flow maps for the Gallia and the Berea Sandstone are presented on Plates VIII and IX (Appendix A), respectively. The groundwater elevation measurements used to develop these maps are presented in Table 2.1.

2.3.1 Hydraulic Properties

Several single-well aquifer tests were performed by Geraghty & Miller in 1989 (Geraghty & Miller, Inc., 1989a) at the PORTS facility to estimate the hydraulic conductivity of the Berea (the lowermost aquifer). Measured hydraulic conductivity values of the Berea range from 4.5×10^{-3} to 15 feet per day (ft/d), with a mean value of 0.16 ft/d. The arithmetic mean of hydraulic conductivity measurements in the Berea at X-616 (where the Sunbury is absent and the Berea may be eroded and weathered) is 0.35 ft/d. The general range for hydraulic conductivity of sandstones is 3.0×10^{-5} to 30 ft/d (deMarsily, 1986). Although two joint sets have been measured at the PORTS facility (N65°E and N25°W), significant secondary permeability in the Berea Sandstone has not been noted in previous investigations at the site.

The hydraulic conductivity of the Gallia, as determined by single-well tests across the entire PORTS facility, varies from 0.11 to 150 ft/d with an arithmetic mean value of 3.4 ft/d. At the X-616 unit, the arithmetic mean of hydraulic conductivity measurements is 1.2 ft/d. A short-term test performed by Geraghty & Miller (1986a) in the vicinity of X-749 gave a hydraulic conductivity for the Gallia of 1.8 ft/d. Multiple-well aquifer tests were performed at X-701B and X-231B (Quadrant I) by Geraghty & Miller (1990a, 1991) to estimate hydraulic properties of the Gallia. Based on an average thickness of 5 feet, estimated hydraulic conductivity values in the Gallia range from 24 to 104 ft/d at X-701B, with arithmetic mean and median values of 49

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ft/d and 44 ft/d, respectively. The X-231B test yielded values between 6.8 and 62 ft/d, with an arithmetic mean, median and geometric mean values of 38 ft/d, 40 ft/d and 31 ft/d, respectively. At X-749 and X-120, slug tests have yielded hydraulic conductivity values ranging from 0.5 to 57 ft/d in the Gallia. Two aquifer tests were also performed as part of recent field investigations carried out at the X-749/X-120 area. These tests showed that the hydraulic conductivity values of the Gallia range from 1.9 to 8.1 ft/d in the southern part of the X-749 plume (HAZWRAP, 1993). The hydraulic conductivity of the Gallia is generally higher in areas of thicker accumulation. The storage coefficient for the Gallia also varies considerably at the facility, ranging from 0.00011 to 0.41, with an arithmetic mean of 0.16 (Geraghty & Miller, Inc., 1989a).

Numerous laboratory measurements of hydraulic conductivity for the Minford clay and silt units were performed by Law Engineering Testing Company (1982). These tests showed that the average permeability of the Minford Clay is 2.3×10^{-4} ft/d and the average permeability of the Minford Silt is 4.3×10^{-3} ft/d. Laboratory analyses of two Minford silt and clay cores collected in the X-701B area (Quadrant II) by Geraghty & Miller (1986b, and 1992) yielded vertical hydraulic conductivity estimates of 2.16×10^{-5} ft/d and 1.3×10^{-4} ft/d. Geraghty & Miller (1989a) performed a single-well aquifer test in the Minford at the X-616 unit (Quadrant III), which yielded a hydraulic conductivity value of 0.62 ft/d. Based on these low hydraulic conductivity values, the Minford clay is considered to be an effective aquitard.

2.3.2 Groundwater Recharge and Discharge Areas

Groundwater recharge and discharge areas at the PORTS facility include both natural recharge and discharge areas, and man-made recharge and discharge areas. Both types are discussed in detail in the following sections.

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2.3.2.1 Natural Recharge and Discharge Areas

The primary source of recharge to the hydrogeologic flow system at the PORTS facility is from precipitation. Net recharge, the amount of water available for infiltration, has been previously estimated to range between 8.9 and 13.9 inches per year using the empirical Thorthwaite method (Geraghty & Miller, Inc., 1989b, 1990b). However, direct infiltration from precipitation is probably less than that cited above because the continuity and low permeability of the Minford, especially the uppermost clay unit, reduce infiltration into the groundwater flow system. Where the clay unit of the Minford is thin to absent, recharge in the range cited above is more likely. However, in other parts of the facility, recharge could be as low as 2 to 4 inches per year, which is the average for this part of Ohio (Pettyjohn and Henning, 1979). Law Engineering Testing Company (1982) estimated net recharge to the Gallia for two scenarios: 0.1 inch per year where approximately 11 feet of clay exist and 3.9 inches per year where approximately 5 feet of silty clay exist. Generally, it can be assumed that little recharge to the Gallia occurs where the Minford clay is greater than 10 feet thick. Buildings and paved areas further reduce infiltration to the Gallia groundwater flow system. A minimal volume of recharge occurs via lateral inflow from off-site portions including the surrounding uplands.

Recharge to the Berea flow system is limited by the presence or absence of the confining Sunbury Shale. The main recharge area for the Berea in the vicinity of PORTS is just west of the X-326 Process Building where the Sunbury Shale is absent (Plate IX in Appendix A).

Groundwater at the PORTS facility discharges primarily to surface streams, to the extensive storm drain network, and to many of the ponds and lagoons on-site. Little Beaver Creek is a local discharge area for all geologic units in the northern and

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northeastern portions of the site. Along the western boundary of the site, the West Drainage Ditch serves as a local discharge area for all geologic units. Groundwater in the southern portion of the facility discharges to Big Run Creek and to the Southwest Unnamed Drainage. All of these surface-water units greatly influence groundwater flow directions in the part of the facility where they are located (Plates VIII and IX in Appendix A).

2.3.2.2 Man-Made Recharge and Discharge Areas

Groundwater recharge and discharge areas at the PORTS facility are affected by numerous man-made features: the Storm Sewer System, the Sanitary Sewer System, the Recirculating Cooling Water system, and building sumps. The Storm Sewer System consists of numerous large-diameter culverts and pipes that drain surface water from discrete segments of the site. The drain system and backfill in which the drains are constructed probably act as interceptor trenches in the Minford and, in certain areas, within the Gallia. Based upon a review of groundwater flow data, this system does not appear to have a significant effect on groundwater flow in the Gallia. Groundwater collected by these drains is transported to the discharge point for each storm drain. Discharge points for the storm drains generally coincide with site National Pollutant Discharge Elimination System (NPDES) outfalls that eventually discharge to the surface-water units described above.

Two other systems of underground lines that may affect groundwater flow at the PORTS facility are the Recirculating Cooling Water system and the Sanitary Sewer System. Both of these systems of underground lines are generally located within 10 to 12 feet of the ground surface. The depth to groundwater is generally 16 feet below ground surface at the site. Consequently, both systems and the backfill associated with the systems are usually located above the local water table. The Recirculating Cooling

Water system is also pressurized to ensure proper transport of return cooling water. Because the Recirculating Cooling Water system is pressurized, it could be a source of recharge to groundwater. Because of these factors, neither of these systems appear to act as a major discharge area for groundwater. However, based upon existing groundwater flow data, recharge from these lines to groundwater appears to be insignificant.

One major man-made feature that significantly affects groundwater flow at the site is a set of building sumps located in the X-700 and X-705 buildings. Sumps in these buildings are pumped at an average rate of 24,200 gallons per day (gpd) in order to keep the basements dry. This pumpage has a significant effect on groundwater flow because it creates a large cone of depression that is centered around the active sumps. The Sunbury Shale also thins or may be absent in this area. Vertical gradients in the area indicate potential upward flow from the Berea to the Gallia. Based upon existing groundwater flow data, no other building sumps appear to have a significant effect on groundwater flow at the PORTS facility.

2.3.3 Groundwater Flow

Groundwater flow directions and gradients at the PORTS facility are influenced by complex and numerous interactions between the hydrogeologic units, natural surface drainages, and man-made features at the site. Interactions between hydrogeologic units include variable communication between the Gallia, Sunbury and Berea and between the Gallia and Minford. Groundwater flow directions in the Gallia and Berea are similar across the site. Both upward and downward gradients occur between the units. Local groundwater flow in these units is strongly influenced by the natural drainage features Little Beaver Creek, Big Run Creek, the West Drainage Ditch and the

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Unnamed Southwest Drainage, and to a lesser extent, man-made drainage features (the Storm Sewer System) that act as discharge areas.

As shown on Plate VIII (Appendix A), groundwater flow at the site can generally be divided into four separate flow regions separated by small groundwater divides. These groundwater divides provided the basis for separation of the reservation into quadrants for RFI purposes; the quadrant boundaries generally follow the flow divides. The groundwater flow divides migrate slightly depending upon seasonal changes in precipitation that lead to changes in the amount of groundwater recharge. The flow divides migrate toward areas that receive a larger amount of recharge from precipitation. These areas include locations in which the Minford Clay or extensive surface paving and/or buildings are absent. Pumping of sumps in the X-700/X-705 area causes flow divides to migrate away from this area as pumping increases. These changes in the location of the divides occur as the groundwater flow system at the site develops dynamic equilibrium. Of all the variables affecting groundwater flow direction, surface-water drainage at the site shows the greatest influence. Groundwater in the Gallia in each flow region ultimately discharges to a surface-water drainage. The interaction between recharge areas and surface-water drainages ultimately controls the location of the groundwater flow divides in the Gallia. Other less important factors affecting the locations of the divides include seasonal changes in precipitation and pumping from sumps in the X-700/X-705 buildings. The effect of either of these factors on the location of the groundwater flow divides is minor compared to the effect of the site surface-water drainage system.

2.3.3.1 Quadrant I - Southern Flow Region

The direction of groundwater flow in the southern portion of the facility (Quadrant I) is controlled by the presence of surface drainages (Big Run Creek and the Unnamed Southwest Drainage), the Storm Sewer System, and bedrock topography. In general, groundwater in the Gallia flows from north to south, discharging into either the Big Run Creek or the Unnamed Southwest Drainage (Plate VIII in Appendix A). Groundwater in the Gallia in the south-central portion of the site (near X-231B) flows primarily to the southeast toward the X-230K Holding Pond, which in turn discharges to Big Run Creek. The hydraulic gradient is very low because of the flat valley floor, the presence of thicker, more permeable Gallia deposits, and the proximity to the east-west groundwater divide that runs through the facility. Storm drains have been observed to affect the local flow system at X-231B (Geraghty & Miller, Inc., 1989a). The vertical hydraulic gradient from the Gallia to the Berea is steep, with an average difference of 8 to 10 feet near X-231B. The vertical hydraulic gradient between the Gallia and Berea decreases to the west as the Sunbury thins.

The groundwater flow system near X-749 exhibits secondary north-south divides in both the Gallia and Berea (Plates VIII and IX in Appendix A). The divide in the Gallia is located near the western boundary of the landfill. Groundwater flows away from the divide to the east toward the Big Run Creek and to the west toward the Unnamed Southwest Drainage. The storm sewers associated with the Gaseous Centrifuge Enrichment Process (GCEP) area influence groundwater flow along the western edge of Quadrant I. A bedrock high located south of the southern edge of the plant site causes groundwater to flow in an east-west direction in this area. Groundwater gradients are steep along the Big Run Creek because of the presence of sediment with low conductivity and the abrupt drop in elevation toward the creek. The vertical component of flow is downward into the Berea with a difference in Gallia and

Berea water levels ranging from 10 to 15 feet. Groundwater flow directions in the Berea in the area are very similar to the directions observed in the Gallia. The north-south groundwater divide occurs farther west in the Berea than in the Gallia, with flow to the east toward the Big Run Creek and to the west toward the Unnamed Southeast Drainage.

2.3.3.2 Quadrant II - Eastern Flow Region

Groundwater flow in the eastern flow region (Quadrant II) is influenced by such factors as the presence or absence of the Sunbury Shale, Little Beaver Creek, holding ponds and drainage ditches, bedrock topography, building sumps, and Minford Clay thickness. The Little Beaver Creek is the local surface-water receptor for shallow groundwater flow in the area. Much of the groundwater in the Minford and Gallia along the eastern portion of the site migrates toward the creek. The Storm Sewer System in the area is typically completed within the Minford. The impact of this system, as well as the Sanitary Sewer System and Recirculating Cooling Water system, on local groundwater flow direction appears to be limited in this area.

Groundwater flow directions in the Minford and the Gallia are affected by the presence of drainage ditches and holding ponds, the most prominent in the area being the X-230J7 Holding Pond and East Drainage Ditch (EDD) (Plate VIII in Appendix A). Both the holding pond and drainage ditch were excavated to bedrock, causing seepage faces to develop where the water table intersects the land surface along the side walls in the Minford and the Gallia. As a result, groundwater near the holding pond and drainage ditch converges toward these local discharge areas.

Groundwater flow in the Berea in this area is primarily east to northeast. The flow direction in this area results from the increased communication between the

Gallia and Berea due to the thinning or absence of the Sunbury along the western portion of the site. In most areas, the flow is downward from the Gallia to the Berea. Vertical hydraulic gradients between the Gallia and Berea are greatest where the Sunbury is a thick, competent shale. Groundwater flow through the Sunbury is assumed to be essentially vertical. Near the X-705/X-700 buildings where the Sunbury is thin or absent, vertical gradients indicate possible upward flow from the Berea to the Gallia. However, sumps located in the basement at the X-705 building pump at an average rate of 21,500 gpd. This pumpage has a significant effect on groundwater flow because it creates a cone of depression centered around the active sumps.

Paved areas, buildings, and thick upper Minford clay and Sunbury Shale deposits effectively reduce recharge to underlying units throughout the PORTS facility. West of X-701B, recharge to the Minford and Gallia is reduced because a large percentage of the land is paved or covered by buildings. Consequently, water levels are lower in the Minford and Gallia in this area (Plate VIII in Appendix A).

2.3.3.3 Quadrant III - Western Flow Region

Groundwater flow in the western flow region (Quadrant III) is influenced by such factors as the presence or absence of the Sunbury, storm drains, holding ponds and drainage ditches, bedrock topography, buildings, paved areas, and the thickness of the clay portion of the Minford. The West Drainage Ditch is the local surface-water receptor for groundwater in the area. As a result, much of the groundwater in the Minford and Gallia in the area migrates to the west and eventually discharges to the upper tributaries of the ditch. Storm drains in the area are typically completed within the Minford. The impact of the drains on local groundwater flow appears to be limited.

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The flow directions in the Minford and Gallia are affected by the presence of drainage ditches and holding ponds, the most prominent in Quadrant III being the X-2230N Holding Pond and the West Drainage Ditch. The West Drainage Ditch is deeply incised into bedrock, especially west of the perimeter road, intercepting much of the groundwater in the Minford and Gallia flowing west of the perimeter road. Seepage faces develop where the water table intersects the land surface along the side walls of the ditches in both the Minford and Gallia. Groundwater near drainage ditches and holding ponds converges toward these local discharge areas (Plate VIII in Appendix A).

Although regional groundwater flow in the Berea Sandstone is northwest to southeast, along the western portion of Quadrant III, the direction of groundwater flow in the Berea has been altered by the West Drainage Ditch and by the erosion of the Berea by the Scioto River Valley to the west. In this area, groundwater flow is primarily to the west. The thinning and absence of the Sunbury along the western portion of the site, including much of Quadrant III, increases connection between the Gallia and the Berea; in most areas the flow is downward from the Gallia to the Berea. Vertical hydraulic gradients between the Gallia and Berea are greatest where the Sunbury Shale is thickest.

Land use and the presence of thick upper Minford clay deposits and the Sunbury Shale effectively reduce recharge to underlying units. Along the eastern portion of Quadrant III, recharge to the Minford and Gallia is reduced because a large percentage of the land is paved or covered by buildings. However, recharge to the Berea from the overlying Gallia is increased due to the absence of the Sunbury Shale. The recharge area for the Gallia is located east of the West Drainage Ditch (Plate VIII in Appendix A). The recharge area for the Berea is located east of X-616; this area is depicted as a groundwater mound on Plate IX (Appendix A). The bedrock valley

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walls bordering the western portion of Quadrant III are composed of shale and, therefore, contribute little groundwater recharge to the area.

2.3.3.4 Quadrant IV - Northern Flow Region

Groundwater flow in the northern portion of the facility (Quadrant IV) is strongly controlled by the presence of surface drainages and bedrock highs: the Little Beaver Creek, the North Drainage Ditch, and, to a lesser extent, the Northeast Drainage Ditch. The Little Beaver Creek is the surface-water receptor for groundwater in the Gallia and Berea in the area (Plates VIII and IX in Appendix A). Groundwater flow in the Gallia in the south and southeastern portion of Quadrant IV is strongly controlled by an east-west groundwater flow divide that roughly parallels the Quadrant IV boundary. The divide is very prominent in the south along the Quadrant II/Quadrant IV boundary near a bedrock high of Cuyahoga Shale northeast of the X-633 cooling tower system (Plates III and IV in Appendix A). The groundwater potentiometric surface in the unconsolidated sediments forms a mound in this area, with steep gradients and radial flow outward toward the Little Beaver Creek, the North Drainage Ditch, and the Northeast Drainage Ditch (Plate VIII in Appendix A). This groundwater mound is due primarily to the bedrock high but may also be the result of leakage from the X-633 cooling tower basins in this area.

In the northern portion of Quadrant IV, groundwater in the Gallia (near the X-735 landfill) flows south and southwest toward Little Beaver Creek. Groundwater is discharged as seeps and surface water to the Little Beaver Creek and the North Drainage Ditch where they have cut through the Gallia. Groundwater flow in the northwestern portion of Quadrant IV, in the vicinity of the X-734 landfill, is northeast toward the North Drainage Ditch and Little Beaver Creek. Gradients in both the

Gallia and Berea steepen toward these surface-water discharges where the units intersect the land surface along the sides of the ditch and creek valleys.

Groundwater flow in the Berea is parallel to that in the Gallia, with flow primarily to the east and north towards the Little Beaver Creek and, to a lesser extent, toward portions of the North Drainage Ditch. Because the Berea underlies the Sunbury Shale, groundwater flow in the Berea is unaffected by the bedrock high of the Cuyahoga Shale near X-633 (Plate IX in Appendix A). As a result, the major east-west flow divide that is present in the Gallia is not present in the Berea.

In most areas, potential flow is downward from the Gallia to the Berea. These vertical gradients result from the low hydraulic conductivity of the Sunbury Shale, which separates the Gallia and Berea. Vertical hydraulic gradients are steepest near the bedrock high in the eastern portion of Quadrant IV (0.64 to 0.76) and in the northwestern portion of Quadrant IV around the X-734 landfill area (0.41 to 0.90). Where the Sunbury is present, all well pairs exhibit a downward gradient from the Gallia to the Berea. The thinning of the Sunbury along the western portion of Quadrant IV generally results in lower gradients. Upward gradients in the Berea are observed where the Sunbury Shale is absent, along the east-west flow divide in the southern portion of Quadrant IV near the Quadrant III/IV boundary (F-11G/F-12B = -0.04, F-07G/F-08B = -0.0004 and X330-PZ05G/X330-PZ04B = +0.11).

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3.0 CHARACTERIZATION OF WASTES

3.1 Introduction

All known waste and process substances disposed or used at the PORTS facility in Quadrant III have been identified on the Unit Data Sheets in Section 6.0 of the Quadrant III DOCC (Geraghty & Miller, Inc., 1992). A list of these wastes and process substances is included in Table 3.1. A Waste Characterization Data Sheet has been prepared for each waste constituent (Appendix B). The Waste Characterization Data Sheets include the hazard classification, description of physical and chemical properties, and nature of migration and dispersal properties of each constituent. Most of the wastes in Quadrant III occur as mixtures; their physical and chemical properties (particularly migration and dispersal properties) may be different from those of the individual constituents. Therefore, bench-scale studies involving chemical and biological tests may be conducted during the CMS, if required. The approach to the compilation of the data sheets is discussed below.

3.2 Waste Characterization Data Sheets

The primary task in the characterization of wastes was to describe their properties by reviewing published literature. The primary sources of information were Material Safety Data Sheets (Genium Publishing Company, 1989); the *Merck Index* (Budavari, ed., 1989); the *Handbook of Environmental Fate and Exposure Data for Organic Chemicals* (Howard, 1989); *the Handbook of Environmental Fate and Exposure Data for Organic Chemicals* (Howard, 1990); *Groundwater Chemicals Desk Reference* (Montgomery, 1991); *Chemical, Physical, and Biological Properties of Compounds Present at Hazardous Waste Sites* (Clement Associates, Inc., 1985); *Water-Related Environmental Fate of 129 Priority Pollutants* (U.S. EPA, 1979); and the *Treatability Database* (U. S.

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EPA, 1991). These and other references provide physical and chemical properties, National Fire Protection Association hazardous classifications, and health effects (Immediate Danger to Life and Health [IDLH] Values), as well as other pertinent information. Additional references are included on the individual Waste Characterization Data Sheets (Appendix B).

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3.3 References

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4.3.10 X-744S, X-744T, X-744U Warehouses

4.3.10.1 Unit Description

Approximately 80,000 cubic yards (yd^3) of lithium hydroxide is stored in the X-744S, X-744T, and X-744U Warehouses. Prior to 1988, the lithium hydroxide was containerized in as many as 3,500 cardboard drums weighing 425 lbs each. In 1984, storage deficiency notices were issued by the OEPA and U.S. DOE because lithium hydroxide spilled from deteriorated cardboard drums that were in direct contact with precipitation. In 1988, the lithium hydroxide was repacked in 75-gallon steel drums and the warehouses were repaired to prevent precipitation leakage.

In 1989, an unknown quantity of paint thinner was reportedly discarded onto the ground in the X-744STU area following painting of the warehouses.

A soil gas survey conducted in 1988 indicated the presence of hydrocarbons in the current construction field office area southwest of X-744T.

4.3.10.2 Potential Contaminants

Lithium hydroxide has been identified as a potential contaminant in this unit. Paint thinner and hydrocarbons are also potential contaminants at X-744STU.

4.3.10.3 Potential Releases

A lithium hydroxide release could impact the surrounding soil and could potentially migrate downward to contaminate groundwater. Paint thinner and hydrocarbons released to surface soils in the area could potentially migrate downward to contaminate groundwater.

4.3.10.4 Summary of Investigation: Phase I

UNIT INVESTIGATION SAMPLING POINTS					
Unit	Well(s)	Soil Boring	Hand Auger	Sediment	Surface Water
X-744STU Lithium Storage Warehouses	--	--	X744S-HA01 through X744S-HA20	--	--

To determine if releases to soils at this unit had occurred, 20 soil samples (0 to 2 feet) were collected in the vicinity of the unit using a stainless-steel hand auger. Twelve samples (X744S-HA01 through X744S-HA03, X744S-HA05 through X744S-HA08, X744S-HA11, X744S-HA12, X744S-HA15, X744S-HA17, and X744S-HA20) were submitted for Level III analyses of TCL/TAL, Freon-113, fluoride, lithium, and radiological parameters (X744S-HA02 was also analyzed for transuranics and isotopic uranium). Eight samples (X744S-HA04, X744S-HA09, X744S-HA10, X744S-HA13, X744S-HA14, X744S-HA16, X744S-HA18, and X744S-HA19) were submitted for Level III analyses of TCL, Freon-113, and lithium. Samples from all locations were also analyzed on-site with a field GC (Level II) for trichloroethene.

4.3.10.5 Analytical Results: Phase I

4.3.10.5.1 Results of Soil Analyses: Phase I

A list of analytes detected in soil samples collected at X-744S is presented in Appendix D1; a matrix of detected organic compounds and radiological parameters is presented in Table 4.18a. Sampling locations are shown on Plate I (Appendix A). Maps showing sample locations and associated analytical results for soil samples collected at this unit are presented on Figures 4.13a through 4.13d.

VOCs were detected in 17 of 22 samples collected from 20 locations. Tetrachloroethene was detected in 13 soil samples at concentrations ranging from 2.3J (X744S-HA05D [duplicate], X744S-HA06 and X744S-HA15D [duplicate]) to 55 μg/kg (X744S-HA11). 1,1,1-Trichloroethane was detected at X744S-HA15D (duplicate) and X745S-HA20 at concentrations of 3.0J μg/kg and 1.3J μg/kg, respectively. 1,1-Dichloroethene and chlorobenzene were detected at X744S-HA14 at concentrations of 4.7J μg/kg and 8.7 μg/kg, respectively. Chloroform was detected at X744S-HA17 at a concentration of 1.9 μg/kg. Ethylbenzene was detected at X744S-HA01, X744S-HA02, and X744S-HA03 at concentrations of 1.1J μg/kg, 4.5J μg/kg, and 5.0J μg/kg, respectively. Trichloroethene was detected at X744S-HA14, X744S-HA15D (duplicate) and X744S-HA18 at concentrations of 5.5J μg/kg, 4.3J μg/kg, and 1.3J μg/kg, respectively. Xylenes were detected at X744S-HA02 at a concentration of 1.3J μg/kg. No other VOCs were detected in soil samples collected at this unit.

SVOCs were detected in three of 22 samples collected from 20 locations. Di-n-butylphthalate was detected at X744S-HA04 at a concentration of 79 μg/kg. Bis(2-ethylhexyl)phthalate was detected at X744S-HA06 at a concentration of 1,400 μg/kg. Benzoic acid was detected at X744S-HA11 at a concentration of 45J μg/kg. PAHs were detected in 17 of 22 samples collected from 20 locations. PAHs were detected in 17 soil samples at concentrations below PQLs. PCBs were detected in six of 22 samples collected from 20 locations. Aroclor-1260 was detected in six soil samples at concentrations ranging from 100 μg/kg (X744S-HA05D [duplicate] and X744S-HA15D [duplicate]) to 190 μg/kg (X744S-HA16). No other SVOCs, PCBs, or pesticides were detected in soil samples collected at this unit.

Radiological parameters were detected in 14 of 14 samples collected from 12 locations. Total uranium was detected in 14 samples at concentrations ranging from 2.7

mg/kg (X744S-HA11 and X744S-HA20) to 3.7 mg/kg (X744S-HA01). No other radiological parameters were detected in soil samples collected at this unit.

Level II field-GC analyses for trichloroethene are presented in Appendix E. No trichloroethene was detected in soil samples collected at this unit.

4.3.10.6 Summary of Investigation: Phase II

UNIT INVESTIGATION SAMPLING POINTS					
Unit	Well(s)	Soil Boring	Hand Auger	Sediment	Surface Water
X-744STU Lithium Storage Warehouses	--	--	X744S-HA21 X744S-HA22 X744S-HA23	--	--

To determine the maximum concentrations and to confirm Level II results of the Phase I investigation, three soil samples, X744S-HA21, X744S-HA22, and X744S-HA23, were collected from a depth of 4 to 6 feet. The Phase II locations, X744S-HA21, X744S-HA22, and X744S-HA23 were located adjacent to the Phase I locations X744S-HA14, X744S-HA16, and X744S-HA18, respectively. The soil samples were collected using a stainless-steel, hand auger. All of these samples were submitted for Level III analyses of PCBs and analyzed on-site with a field GC (Level II) for trichloroethene.

All sample locations associated with Quadrant III are shown on Plate I (Appendix A).

4.3.10.7 Analytical Results: Phase II

4.3.10.7.1 Results of Soil Analyses: Phase II

A list of analytes detected in soil samples collected at X-744S is presented in Appendix D1; a matrix of detected organic compounds and radiological parameters is presented in Table 4.18b. Sampling locations are shown on Plate I (Appendix A). Maps showing sample locations and associated analytical results for soil samples collected at this unit are presented on Figures 4.13a through 4.13d.

PCBs were detected in two of four samples collected from three locations. Aroclor-1260 was detected at X744S-HA21-06 ft and X744S-HA23-06 ft at concentrations of 43J μg/kg and 29J μg/kg, respectively. No other PCBs were detected in soil samples collected at this unit.

Level II field-GC analyses for trichloroethene are presented in Appendix E. No trichloroethene was detected in soil samples collected at this unit.

4.3.10.8 Discussion

During the Phase I investigation, VOCs were detected above PQLs at seven of 20 soil sample locations. SVOCs (mostly PAHs) were detected below PQLs in 17 soil samples. PAH concentrations detected at this unit are consistent with or lower than PAH levels detected in soils throughout the site. These levels are consistent with anthropogenic levels associated with nonhazardous waste treatment, storage, and disposal plant operations and infrastructure. Two common SVOC laboratory contaminants, di-n-butylphthalate and bis(2-ethylhexyl)phthalate, were detected above PQLs in two soil samples. Aroclor-1260 was detected above its PQL in four soil samples and below its PQL in two soil samples.

Although background levels for total uranium have not been assessed relative to the BSI, total uranium concentrations do not appear elevated at this unit.

To determine the maximum concentrations of PCBs at depth, additional soil samples were collected during the Phase II investigation. The Phase I samples containing PCBs were collected from locations within the ditch surrounding the contractor trailer area. PCBs were detected at depth in the Phase II soil samples at concentrations below PQLs. Based on the low concentrations detected at depth, the extent of the PCB contamination is confined to the upper 6 feet of soil in the ditch surrounding the contractor trailer area. Based on these results, it appears that a release of VOCs, PCBs, and a possible release of SVOCs has occurred to soils at this unit.

The VOCs detected in soils at the unit are not the source of the VOC contamination in groundwater in the area. VOCs were detected in wells located upgradient of the X-744S, X-744T, and X-744U Warehouses, indicating that the warehouses cannot be the sources of the VOCs in groundwater. Wells downgradient (west) of X-744S, X-744T, and X-744U (X616-22G, X616-23M, and X616-24B) show no VOC contamination, as would be expected if the warehouses were the sources of the VOCs.

Because the nature and extent of contamination in soils and groundwater have been determined, the data is considered complete; no further RFI work is recommended.

The inorganic constituents and radiological parameters for this unit will be evaluated using the results presented in the BSI and will be addressed in the CAS/CMS.

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Figure 4.13a Sample Locations at X-744STU Lithium Storage Warehouse

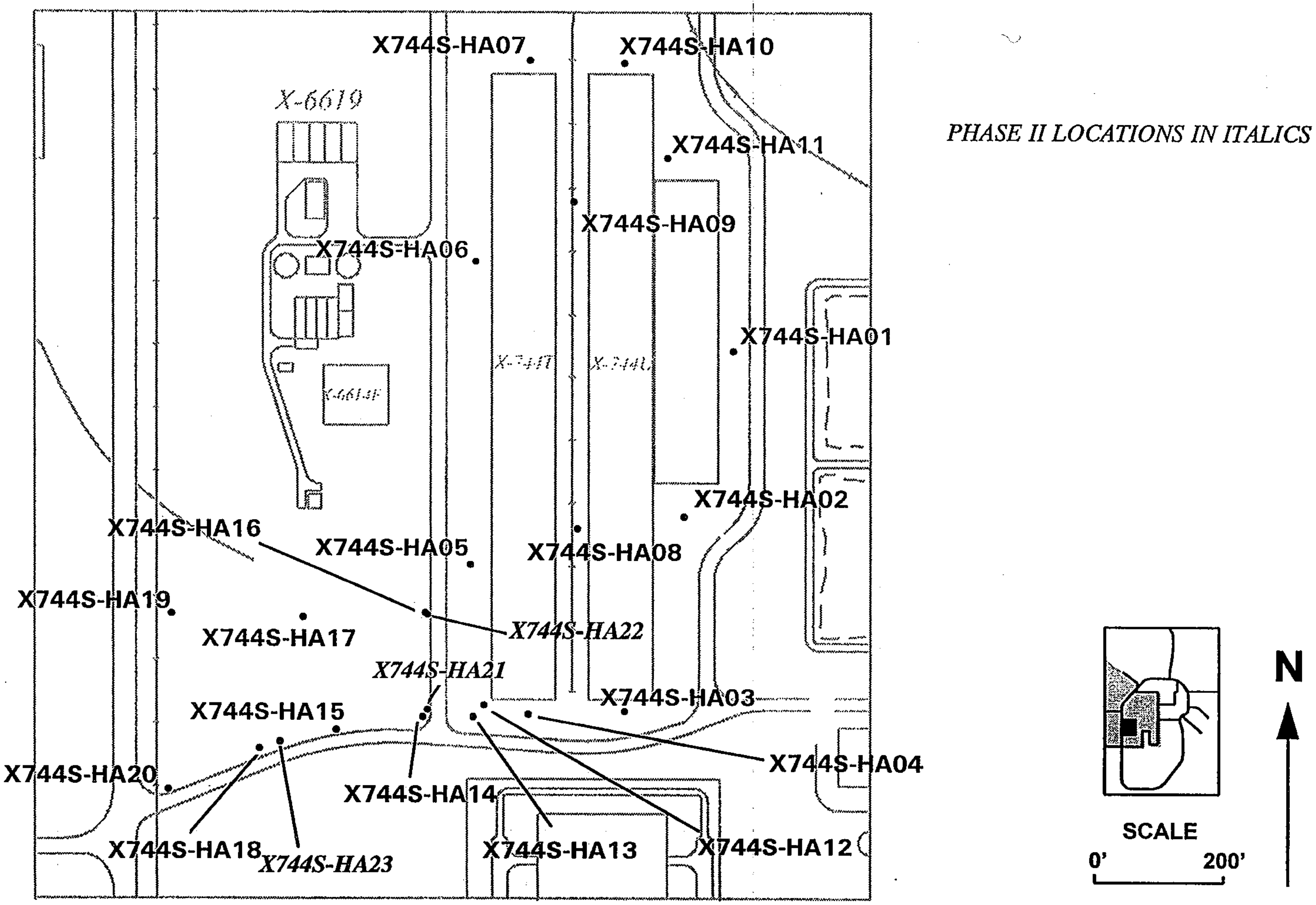

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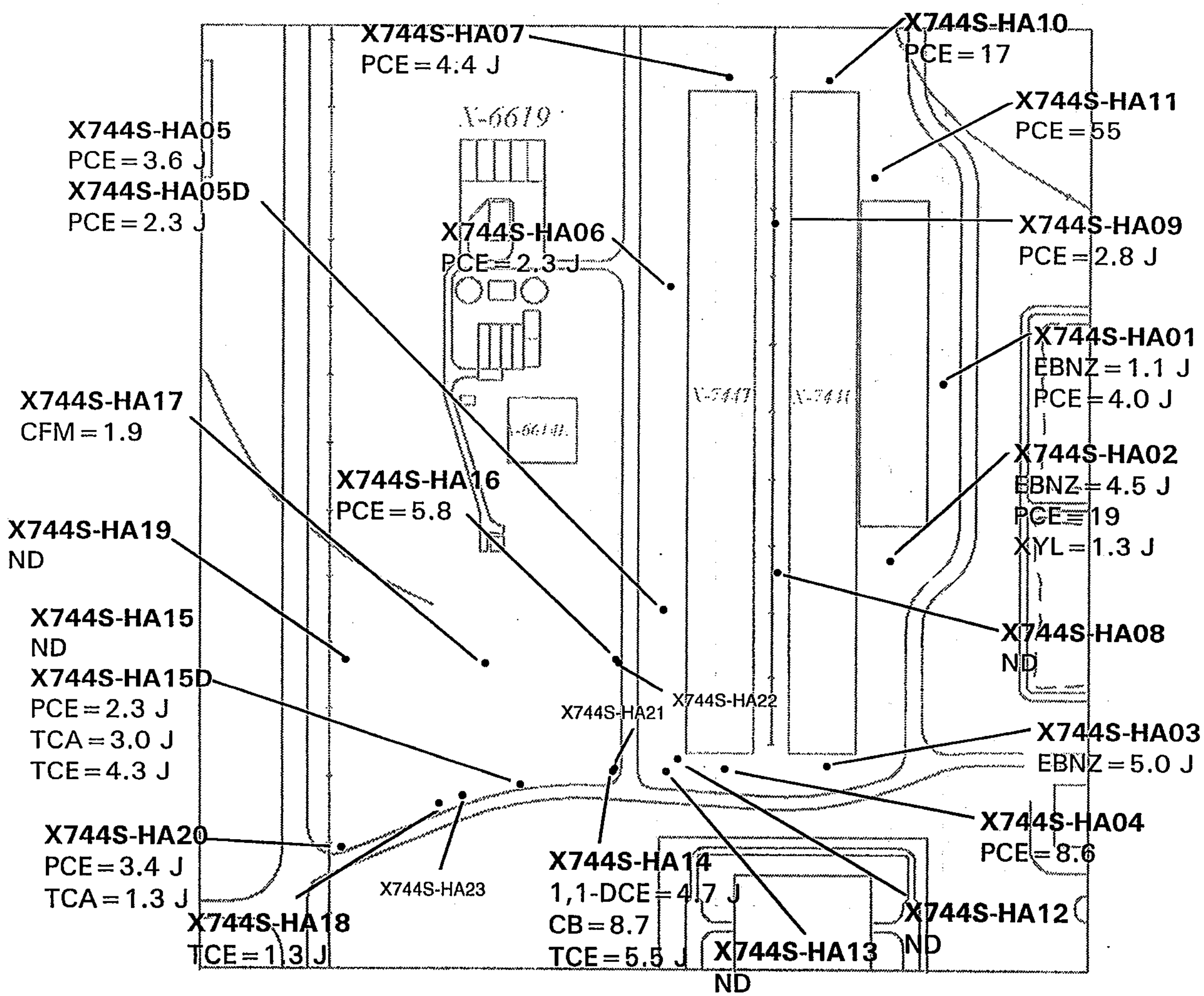
Figure 4.13b Concentration of VOCs in Soil Samples at X-744STU Lithium Storage Warehouse



VOCs (ug/kg)

CB=CHLOROBENZENE
CFM=CHLOROFORM
1,1-DCE=1,1-DICHLOROETHENE
EBNZ=ETHYLBENZENE
PCE=TETRACHLOROETHENE
TCA=1,1,1-TRICHLOROETHANE
TCE=TRICHLOROETHENE
XYL=XYLENE (total)

J=ESTIMATED VALUE
ND=NO VOCs DETECTED

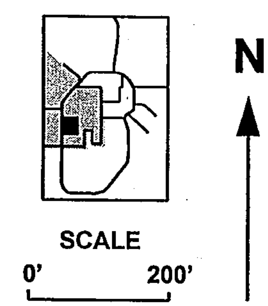


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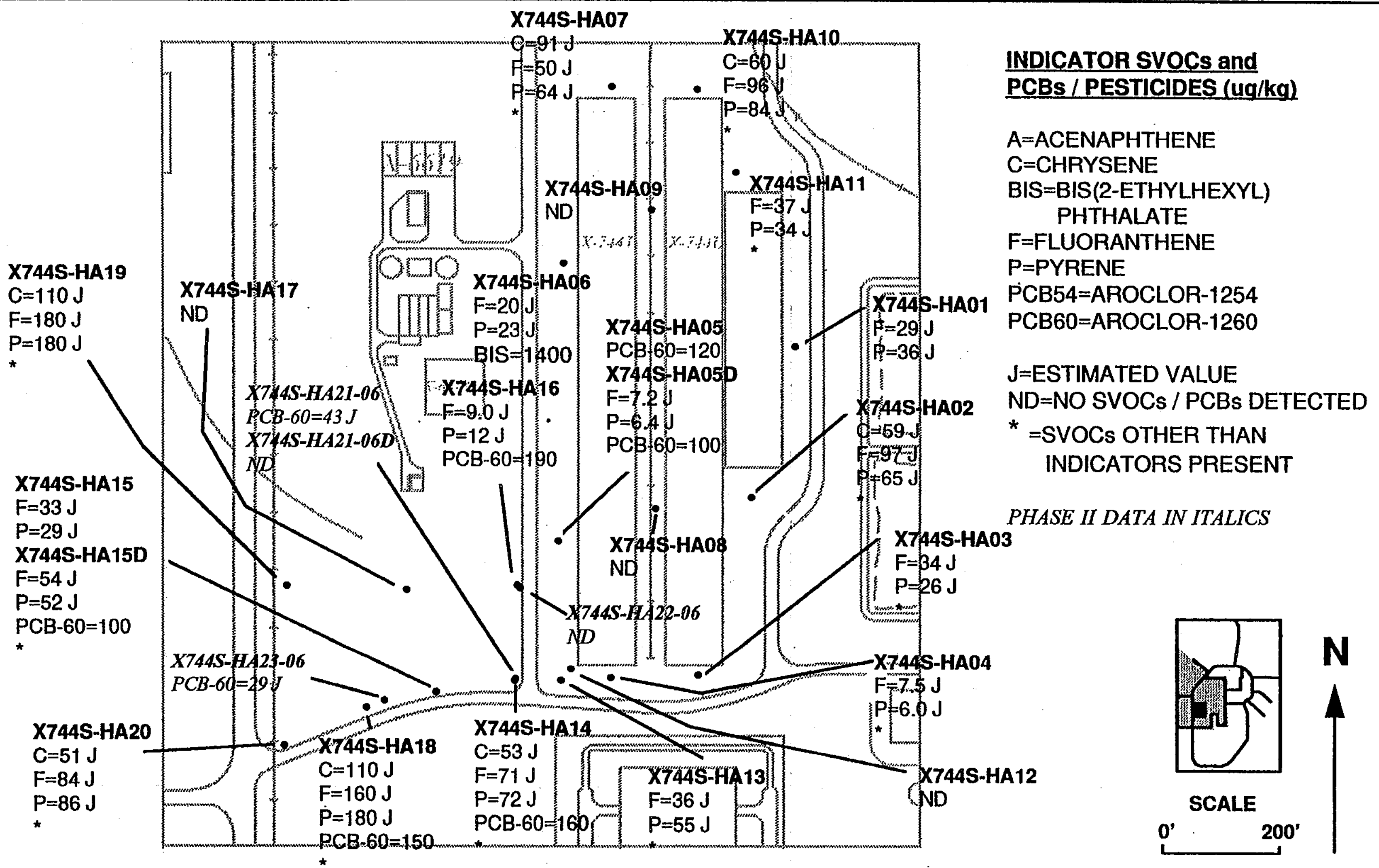
Figure 4.13c Concentration of SVOCs, PCBs, and Pesticides in Soil Samples at X-744STU Lithium Storage Warehouse



INDICATOR SVOCs and PCBs / PESTICIDES (ug/kg)

A=ACENAPHTHENE
C=CHRYSENE
BIS=BIS(2-ETHYLHEXYL) PHTHALATE
F=FLUORANTHENE
P=PYRENE
PCB54=AROCLOR-1254
PCB60=AROCLOR-1260

J=ESTIMATED VALUE
ND=NO SVOCs / PCBs DETECTED
* =SVOCs OTHER THAN INDICATORS PRESENT

PHASE II DATA IN ITALICS

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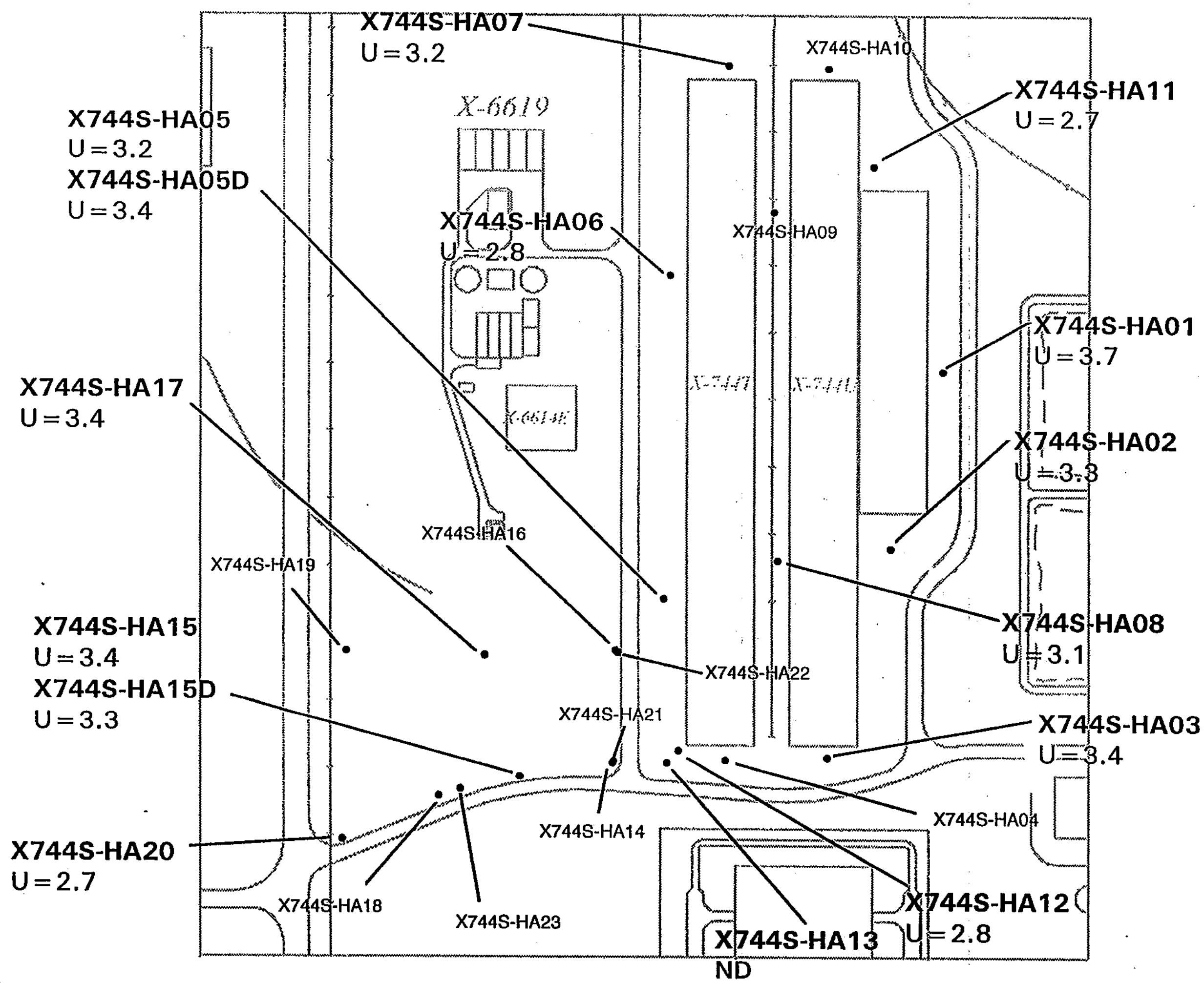
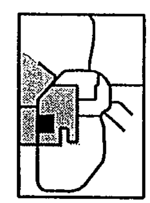
Figure 4.13d Concentration of Radiological Parameters in Soil Samples at X-744STU Lithium Storage Warehouse



RADIOLOGICAL PARAMETERS

U=TOTAL URANIUM (mg/kg)
ALPHA=GROSS ALPHA (pCi/g)
Tc=TECHNETIUM (pCi/g)
BETA=GROSS BETA (pCi/g)

J=ESTIMATED VALUE
ND=NO RADIOLOGICAL PARAMETERS DETECTED



SCALE
0' 200'

N

Table 3.1 Quadrant III Potential Constituents of Concern

Acetone
Asbestos
Cadmium
Cupric arsenate
Chloroform
Chromium
  Hexavalent chromium
  Trivalent chromium
  Chromic (VI) oxide
Copper
Cyanide
1,1-Dichloroethane
1,1-Dichloroethene
2,4-D Ester
cis-1,2-Dichloroethylene
trans-1,2-Dichloroethylene
Diesel fuel (including components)
Ethylbenzene
Ferric sulfate
Fly and Bottom Ash (including components)
Freon-113
Freon-114
Gasoline (including components)
Hydrogen fluoride (hydrofluoric acid)
Kerosene
Lead
Malathion
Mercury
Pentachlorophenol
Polychlorinated Biphenyls
Polynuclear Aromatic Hydrocarbons
Sodium bisulfate
Stoddard Solvent
Sulfuric acid
Technetium
Technetium hexafluoride
Tetrachloroethylene
Toluene
1,1,1-Trichloroethane
Trichloroethylene
Uranium
Uranium hexafluoride
Waste oil (including components)
Xylene
  m-Xylene
  o-Xylene
  p-Xylene
Zinc
Zinc sulfate (in Orocol)

TABLE 4.18a - DETECTED ORGANIC AND RADIOLOGICAL PARAMETERS
SWMU: X-744S LITHIUM STORAGE
SOILS

CHEMICAL	X744S-HA01	X744S-HA02	X744S-HA03	X744S-HA04	X744S-HA05	X744S-HA05D	X744S-HA06
VOLATILE ORGANICS							
1,1,1-TRICHLOROETHANE[ug/kg]	....	....	....	....	....	....	....
1,1-DICHLOROETHENE[ug/kg]	....	....	....	....	....	....	....
ACETONE[ug/kg]	+++++	....	....	....	....	....	....
CHLOROBENZENE[ug/kg]	....	....	....	....	....	....	....
CHLOROFORM[ug/kg]	....	....	....	....	....	....	....
ETHYLBENZENE[ug/kg]	1.1J	4.5J	5.0J	....	....	....	....
METHYLENE CHLORIDE[ug/kg]	....	....	....	....	....	....	....
TETRACHLOROETHENE[ug/kg]	4.0J	19	....	8.6	3.6J	2.3J	2.3J
TOLUENE[ug/kg]	....	....	....	....	....	....	....
TRICHLOROETHENE[ug/kg]	....	....	....	....	....	....	....
XYLENES[ug/kg]	....	1.3J	....	....	....	....	....
SEMIVOLATILE ORGANICS							
ANTHRACENE[ug/kg]	....	....	....	....	....	....	....
BENZO(A)ANTHRACENE[ug/kg]	....	....	....	9.5J	....	....	....
BENZO(A)PYRENE[ug/kg]	....	38J	13J	5.7J	....	....	....
BENZO(B)FLUORANTHENE[ug/kg]	....	52J	20J	4.6J	....	....	....
BENZO(G,H,I)PERYLENE[ug/kg]	....	21J	....	....	....	....	....
BENZO(K)FLUORANTHENE[ug/kg]	....	42J	....	....	....	....	....
BENZOIC ACID[ug/kg]	....	....	....	....	....	....	....
BIS(2-ETHYLHEXYL)PHTHALATE[ug/kg]	....	....	....	....	....	....	1400
BUTYLBENZYLPHTHALATE[ug/kg]	....	....	....	....	....	....	+++++
CHRYSENE[ug/kg]	....	59J	....	....	....	....	....
DI-N-BUTYLPHTHALATE[ug/kg]	....	....	....	79	....	....	....
DI-N-OCTYLPHTHALATE[ug/kg]	+++++	....	....	....	....	....	....
FLUORANTHENE[ug/kg]	29J	97J	34J	7.5J	....	7.2J	20J
FLUORENE[ug/kg]	....	....	....	....	....	....	....
INDENO(1,2,3-CD)PYRENE[ug/kg]	....	21J	....	....	....	....	....
PHENANTHRENE[ug/kg]	....	....	....	....	....	....	....
PYRENE[ug/kg]	36J	65J	26J	6.0J	....	6.4J	23J
PCBs/PESTICIDES							
AROCLOR-1260[ug/kg]	....	....	....	....	120	100	....
RADIOLOGICAL PARAMETERS							
URANIUM, TOTAL[mg/kg]	3.7	3.3	3.4	**********	3.2	3.4	2.8

***** NOT ANALYZED
.... NOT DETECTED
++++ LAB CONTAMINANT DETECTED BELOW PQL
'R' - DATA UNUSABLE
'J' - ESTIMATED VALUE
DUPLICATE SAMPLE IDs END WITH 'D'

TABLE 4.18a - DETECTED ORGANIC AND RADIOLOGICAL PARAMETERS
SWMU: X-744S LITHIUM STORAGE
SOILS

CHEMICAL	X744S-HA07	X744S-HA08	X744S-HA09	X744S-HA10	X744S-HA11	X744S-HA12	X744S-HA13	X744S-HA14
VOLATILE ORGANICS								
1,1,1-TRICHLOROETHANE[ug/kg]	....	....	....	....	....	....	....	....
1,1-DICHLOROETHENE[ug/kg]	....	....	....	....	....	....	....	4.7J
ACETONE[ug/kg]	....	....	....	....	....	....	....	....
CHLOROBENZENE[ug/kg]	....	....	....	....	....	....	....	8.7
CHLOROFORM[ug/kg]	....	....	....	....	....	....	....	....
ETHYLBENZENE[ug/kg]	....	....	....	....	....	....	....	....
METHYLENE CHLORIDE[ug/kg]	....	....	....	....	+++++	....	....	....
TETRACHLOROETHENE[ug/kg]	4.4J	....	2.8J	17	55	....	....	....
TOLUENE[ug/kg]	....	....	....	....	....	....	....	....
TRICHLOROETHENE[ug/kg]	....	....	....	....	....	....	....	5.5J
XYLENES[ug/kg]	....	....	....	....	....	....	....	....
SEMIVOLATILE ORGANICS								
ANTHRACENE[ug/kg]	....	....	....	....	....	....	....	....
BENZO(A)ANTHRACENE[ug/kg]	46J	....	....	46J	....	....	....	....
BENZO(A)PYRENE[ug/kg]	57J	....	....	40J	....	....	....	31J
BENZO(B)FLUORANTHENE[ug/kg]	93J	....	....	42J	27J	....	....	46J
BENZO(G,H,I)PERYLENE[ug/kg]	31J	....	....	22J	....	....	....	....
BENZO(K)FLUORANTHENE[ug/kg]	67J	....	....	....	22J	....	....	27J
BENZOIC ACID[ug/kg]	....	....	....	....	45J	....	....	....
BIS(2-ETHYLHEXYL)PHTHALATE[ug/kg]	+++++	....	+++++	....	+++++	....	....	+++++
BUTYLBENZYLPHTHALATE[ug/kg]	....	....	....	....	....	....	....	+++++
CHRYSENE[ug/kg]	91J	....	....	60J	....	....	....	53J
DI-N-BUTYLPHTHALATE[ug/kg]	....	....	....	....	....	....	....	+++++
DI-N-OCTYLPHTHALATE[ug/kg]	....	....	....	....	....	....	....	....
FLUORANTHENE[ug/kg]	50J	....	....	96J	37J	....	36J	71J
FLUORENE[ug/kg]	....	....	....	....	....	....	....	....
INDENO(1,2,3-CD)PYRENE[ug/kg]	34J	....	....	21J	....	....	....	....
PHENANTHRENE[ug/kg]	....	....	....	36J	....	....	20J	40J
PYRENE[ug/kg]	64J	....	....	84J	34J	....	55J	72J
PCBs/PESTICIDES								
AROCLOR-1260[ug/kg]	....	....	....	....	....	....	....	160
RADIOLOGICAL PARAMETERS								
URANIUM, TOTAL[mg/kg]	3.2	3.1	**********	**********	2.7	2.8	**********	**********

***** NOT ANALYZED
.... NOT DETECTED
++++ LAB CONTAMINANT DETECTED BELOW PQL
'R' - DATA UNUSABLE
'J' - ESTI[illegible]ED VALUE
DUPLIC[illegible]AMPLE IDs END WITH 'D'

TABLE 4.18a - DETECTED ORGANIC AND RADIOLOGICAL PARAMETERS
SWMU: X-744S LITHIUM STORAGE
SOILS

CHEMICAL	X744S-HA15	X744S-HA15D	X744S-HA16	X744S-HA17	X744S-HA18	X744S-HA19	X744S-HA20
VOLATILE ORGANICS							
1,1,1-TRICHLOROETHANE[ug/kg]	....	3.0J	....	....	....	....	1.3J
1,1-DICHLOROETHENE[ug/kg]	....	....	....	....	....	....	....
ACETONE[ug/kg]	....	....	....	....	....	....	....
CHLOROBENZENE[ug/kg]	....	....	....	....	....	....	....
CHLOROFORM[ug/kg]	....	....	....	1.9	....	....	....
ETHYLBENZENE[ug/kg]	....	....	....	....	....	....	....
METHYLENE CHLORIDE[ug/kg]	....	....	....	....	....	....	....
TETRACHLOROETHENE[ug/kg]	....	2.3J	5.8	....	....	....	3.4J
TOLUENE[ug/kg]	....	+++++	....	....	....	....	....
TRICHLOROETHENE[ug/kg]	....	4.3J	....	....	1.3J	....	....
XYLENES[ug/kg]	....	....	....	....	....	....	....
SEMIVOLATILE ORGANICS							
ANTHRACENE[ug/kg]	....	....	....	....	15J	....	....
BENZO(A)ANTHRACENE[ug/kg]	....	....	....	....	....	48J	....
BENZO(A)PYRENE[ug/kg]	....	23J	....	....	83J	45J	....
BENZO(B)FLUORANTHENE[ug/kg]	....	30J	....	....	100J	99J	33J
BENZO(G,H,I)PERYLENE[ug/kg]	....	....	....	....	33J	32J	....
BENZO(K)FLUORANTHENE[ug/kg]	....	27J	....	....	20J	....	....
BENZOIC ACID[ug/kg]	....	....	....	....	....	....	....
BIS(2-ETHYLHEXYL)PHTHALATE[ug/kg]	+++++	+++++	+++++	....	....	....	....
BUTYLBENZYLPHTHALATE[ug/kg]	....	+++++	....	....	....	....	....
CHRYSENE[ug/kg]	....	....	....	....	110J	110J	51J
DI-N-BUTYLPHTHALATE[ug/kg]	....	....	....	....	+++++	+++++	+++++
DI-N-OCTYLPHTHALATE[ug/kg]	....	....	....	....	....	....	....
FLUORANTHENE[ug/kg]	33J	54J	9.0J	....	160J	180J	84J
FLUORENE[ug/kg]	....	....	....	....	7.0J	....	....
INDENO(1,2,3-CD)PYRENE[ug/kg]	....	....	....	....	51J	26J	....
PHENANTHRENE[ug/kg]	....	26J	....	....	87J	55J	70J
PYRENE[ug/kg]	29J	52J	12J	....	180J	180J	86J
PCBs/PESTICIDES							
AROCLOR-1260[ug/kg]	....	100	190	....	150	....	....
RADIOLOGICAL PARAMETERS							
URANIUM, TOTAL[mg/kg]	3.4	3.3	**********	3.4	**********	**********	2.7

***** NOT ANALYZED
.... NOT DETECTED
++++ LAB CONTAMINANT DETECTED BELOW PQL
'R' - DATA UNUSABLE
'J' - ESTIMATED VALUE
DUPLICATE SAMPLE IDs END WITH 'D'

TABLE 4.18b - DETECTED ORGANIC PARAMETERS
SWMU: X-744S LITHIUM STORAGE
SOILS

CHEMICAL	X744S-HA21-06	X744S-HA23-06
PCBs/PESTICIDES		
AROCLOR-1260[ug/kg]	43J	29J

***** NOT ANALYZED
.... NOT DETECTED
++++ LAB CONTAMINANT DETECTED BELOW PQL
'R' - DATA UNUSABLE
'J' - ESTIMATED VALUE
DUPLICATE SAMPLE IDs END WITH 'D'

2371

5.0 GROUNDWATER FLOW MODELING

5.1 Introduction

As part of the Phase II RFI activities at Quadrant III, the existing groundwater flow model was updated, recalibrated, and utilized to further define the Quadrant III groundwater flow system and to evaluate migration pathways for potential contaminants detected during the RFI.

The Phase II model utilized the previously existing calibrated regional model constructed by Geraghty & Miller (1989a), the calibrated Quadrants III and IV RFI Phase I models (Geraghty & Miller, Inc., 1992a; 1993), and the calibrated Quadrants I and II RFI Phase II models (Geraghty & Miller, Inc., 1994a; 1994b). This Quadrant III Phase II model update benefited from a more comprehensive understanding of the site due to the additional data collected during the Quadrants I, II, III, and IV RFI Phase II investigations. Observed groundwater elevations from a total of 219 observation wells in the Minford, Gallia, and Berea were used as calibration targets. A sensitivity analysis and water budget analysis were performed on the calibrated steady-state flow model. Particle tracking was performed to estimate migration pathways and travel times to potential receptors.

The numerical codes, MODFLOW and MODPATH, were used in the analysis. MODFLOW (McDonald and Harbaugh, 1988) is a numerical three-dimensional groundwater-flow code which was used to construct a numerical model of the Quadrant III groundwater-flow system. MODPATH (Pollock, 1989) is a three-dimensional advective particle tracking code which was used in conjunction with MODFLOW to investigate migration pathways and travel times to potential receptors.